KOCED COLLABORATORY PROGRAM: PROGRESS REPORT

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ABSTRACT :

The construction stage of the KOCED Collaboratory Program is in its final year. Five out of six large scale state-of-the-art testing facilities are almost completed and will undergo testing in the fall of 2008. Trial runs of the KOCED Cyberinfrastructure (KOCED CI) will begin near the end of this year. The KOCED CI ties the testing facilities together, links them to users, and provides various collaboration services. All of the testing facilities and CI will be open to the public next year and will be operated on the shared-use basis for the next 15 years by KOCED Consortium. This paper outlines the KOCED program and reports its current construction status of the facilities and the CI. Technical specifications of the testing facilities will be described. Important aspects of data models, various telepresence services, virtual laboratory, and education grid will be introduced.

KEYWORDS: Cyberinfrastructure, KOCED, Testing Facility, Experiment, Earthquake

1. PLAN, MANAGEMENT AND OPERATION

1.1. Plan

Korea's Ministry of Land, Transport and Maritime Affairs 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 industries and technologies.

The KOCED program at the construction stage consists of two parts: the construction of up-to-date large scale

testing facilities and the development of a comprehensive cyberinfrastructure that enables shared-use and collaboration. The geographical locations of the six testing facilities are evenly distributed around the country and hosted by major regional universities as shown in Figure 1. They include the Hybrid Structural Testing Facility, Geotechnical Centrifuge, Multi-Platform Seismic Simulation Facility, Advanced Construction Materials Testing Facility, Wind Tunnel, and Ocean Environment Simulation Facility.

The KOCED CI will be developed to focus on promoting collaboration and facilitating shared-use and access to facilities and other resources. Major components and services of KOCED CI include (1) integrated KOCED CI System, (2) computing cluster, (3) data, information, and knowledge management services, (4) collaboration services, (5) virtual laboratory, (6) education grid and other education services, and (7) online expert consulting and other services for industry. A strong emphasis will be placed on the enhancement of education and learning and the transformation of industrial practices as well as strengthening research capabilities.

According to the program time table in Figure 2, development and construction of these facilities and resources should be completed by April 20, 2009. From that point KOCED Consortium will take over the testing facilities and the cyberinfrastructure and begin to operate them on a shared-use basis for 15 years, from 2009 to 2024. This Consortium will be established by the end of this year. During the year 2024, all the rights to facilities will be turned over to the host universities.

Figure1 Locations of the six testing facilities

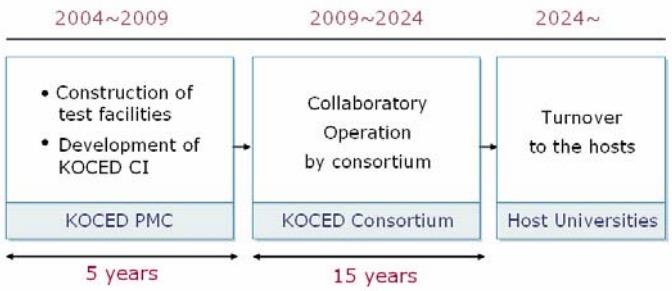


Figure 2 Time table of the KOCED Program

1.2. Program Management

Currently the program is managed by KOCED Program Management Center, with its headquarter located at Seoul National University. The KOCED PMC will play a key role in the execution of the KOCED Program. The mission of the KOCED PMC can be classified into four categories: (1) monitoring and coordinating the construction of experimental facilities; (2) developing the regulatory guides and operation rules for the KOCED Consortium; (3) networking the testing facilities and developing cyberinfrastructure that will link the experimental facilities and other resources seamlessly with users; and (4) developing technologies and services that will enable full capacity of CI to be utilized in research & development, education & learning, and support for industry.

1.3. Operation Policies and Strategies

The Consortium will be the governing body for the Collaboratory and will be a gateway to the facilities, CI, and other resources. Users can access the CI through KOCED Portal online and can receive administrative assistance for the use of the facilities. Operation policies and financing strategies of the Collaboratory is still under development along with more detailed and specific rules and regulations. The agreed-upon guiding principles may be stated as follows:

1. The Consortium will be established and operated as a foundation or a non-profit cooperation.
2. In the long run, the Consortium should be operable without government support. In other words, it should be financially self-sufficient and independent.
3. The managing organization should be optimized in order to minimize operational overhead.
4. The Consortium will not only operate and maintain the facilities but also the CI and other resources of the Collaboratory.
5. However, the Consortium should be able to provide full capabilities and services of CI to the users.
6. Taking into account the well-established rules and procedures of the membership class, users should be able to equitably access and use the facilities, the CI, and other resources.
7. The KOCED Collaboratory will be open not only to the national community but also to the global community.

2. TESTING FACILITIES

2.1. Hybrid Structural Testing Facility

This facility is designed to perform real-time or near real-time pseudo-dynamic or hybrid structural testing of multi-degrees of freedom structural systems and components. The site area is 10,205m^2 and building area 1700m^2. The area of indoor strong floor is 48.9m by 12.8m and the maximum height of reaction walls is 12m tall. A unique feature of this facility is that bridge models of length up to 80m long can be tested utilizing both indoor and outdoor strong floors. It will be equipped with many actuators ranging from 25 ton to 500 ton. This center has facilities for fatigue testing as well. The full view of the facility under construction is provided in Figure 3a and the layout perspective in Figure 3b. Construction of the facility including installation of all the equipments will be completed by the end of October this year. Performance tests followed by a demonstrative test with a real bridge model will begin in November. In February 2009 this facility will be open to general users. The facility is located at Myongji University. The director is Prof. Young Suk Park and can be reached at pys@mju.ac.kr.

(a) The full view of the facility under construction

(b) The layout perspective

Figure 3 Hybrid structural testing facility

2.2. Geotechnical Centrifuge Facility

This facility is intended to perform scaled model tests that can simulate realistic stress field with high level of centrifugal force. The full view of the facility under construction is provided in Figure 4a and the photo of the installed centrifuge in Figure 4b. The structure that houses the centrifuge is separate from the main building of 5 stories. The platform radius of the centrifuge is 5m. It can accelerate the 2400kg payload up to 100g. Unique features of this facility include an advanced 4DOF in-flight robot and a biaxial shake table system. Construction of the facility is almost over and researchers are now testing the performance of the main equipment and other

accessories. But the in-flight robot and shake table system will be delivered by the end of this year. In February 2009 the whole facility will be open to general users. The facility is located at KAIST. The director is Prof. Dong-Soo Kim and can be reached at dskim@kaist.ac.kr.

(a) The full view of the facility under construction

(b) The installed centrifuge

Figure 4 Geotechnical centrifuge facility

2.3. Multi-platform Seismic Simulation Facility

This facility is to perform seismic tests of various models of buildings, bridges and other structures and equipments. The facility is built on site with an area of 10,200m^2. The area of the building is 2,164m^2. The full view of the facility under construction is shown in Figure 5a and the shake tables under installation in Figure 5b. The unique feature of this facility is that it consists of three shake tables that can be excited independently and simultaneously, and these two tables can be translated along the corridor. The maximum movable distance of each table is 20m. This feature will make the facility very suitable to seismic tests of bridge models. The size of two movable tables is 5m by 5m and the fixed one is 4m by 4m. The nominal payload of one movable table is 50 tons and can be accelerated up to 1.25g in two horizontal directions. Provisions are made for hybrid testing combining shake tables and reaction walls. The construction of the facility is almost over and shake tables will be ready for test operation in February 2009. In April 2009 researcher will be able to use the full capacity of the facility. The facility is located at Yangsan campus of the Pusan National University. The director is Prof. Jin Hwan Cheung and can be reached at chung@pusan.ac.kr.

(a) The full view of the facility under construction

(b) The shake tables under installation

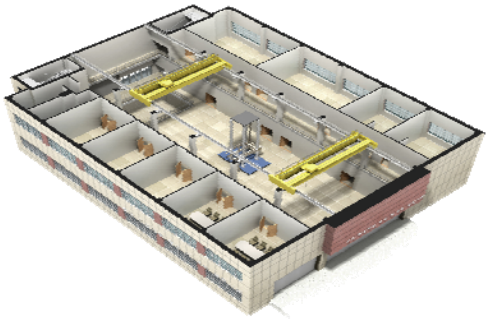
Figure 5 Multi-platform seismic simulation facility

2.4. Advanced Construction Materials Testing Facility

This facility provides the community with time-sharing access to the state-of-the-art equipments necessary for development and performance test of new construction materials and components. The full view of the facility under construction is shown in Figure 6a and the layout perspective of the 2nd floor in Figure 6b. The area of

the site is 5,636m^2 and the building area is 2,165m^2. The three story main building accommodates six laboratories: concrete and rock test lab; metal and composite materials test lab; long term behavior test lab; microstructure test lab; smart sensor and NDT test lab; and structural component test lab. The test center will put strong emphasis on the collaborative research with the industry and has ample space reserved for visiting researchers. Online tests can be carried out remotely through the KOCED CI. Construction of the facility will be completed in October this year. After the test operation, it will be open to the community in February 2009. The facility is located at Keimyung University. The director is Prof. Seung-Han Lee and can be reached at lsh@kmu.ac.kr.

(a) The full view of the facility under construction



(b) The layout perspective of the 2nd floor.

Figure 6 Advanced construction materials testing facility

2.5. Wind Tunnel Facility

This facility is planned to investigate wind induced problems at natural atmospheric boundary layer flow such as wind effects on long span bridges, high rise buildings, urban areas, and various industrial applications. The area of the site is 4,433m^2 and the building area is 1,755m^2. The full view of the facility is provided in Figure 7a and the layout perspective in Figure 7b. The wind tunnel has two test sections: the low speed section which is 12m wide, 2.5m high, and 40m long, and the high speed section which is 5m wide, 2.5m high and 20m long. The corresponding maximum wind speeds are 12m/s and 24m/s. respectively. The unique feature of this facility is that remote users can control and monitor tests in real-time through KOCED CI within a limited range. The construction of the facility is almost over and researchers are testing the performance of the main equipment. In December 2008 the whole facility will be open to general users. The facility is located at Chonbuk National University. The director is Prof. Soon-Duck Kwon and can be reached at sdkwon@chonbuk.ac.kr.

(a) The full view of the facility under construction

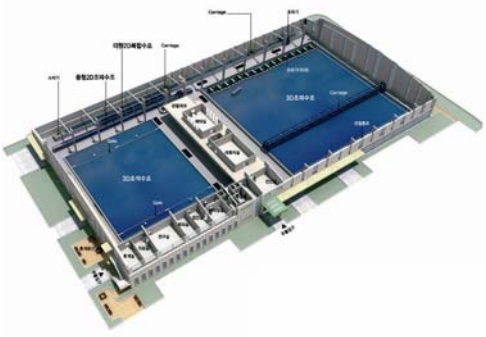
(b) The layout perspective of the facility

Figure 7 Wind tunnel facility

2.6. Ocean Environment Simulation Facility

This large facility will provide the ocean engineering research community with access to wave basins, flumes, and other measurement tools and sensors. The building area of this very large facility is 6,971m^2. It consists of one 3-D wave basin (50m×50m×1.5m), one 3-D tidal basin (30m×40m×1m), and two 2-D wave flumes (100m×2m×3m, 50m×1m×1.3m). The full view of the facility is provided in Figure 8a and the layout perspective in Figure 8b. Strong emphasis will be given on the collaboration between the research community and local government and industry. Application will be expanded beyond the traditional ocean and coastal engineering to marine ecology, fishery, and other environmental problems. The facility will be completed and open to users in February 2010. The facility is being constructed at Chonnam National University, Yeosu. The director is Prof. Tae Ho Kim and can be reached at kimth@chonnam.ac.kr.

(a) The full view of the facility



(b) The layout perspective

Figure 8 Ocean environment simulation facility

3. CYBERINFRASTRUCTURE(CI)

3.1. KOCED CI System

The KOCED Collaboratory is planned and built as distributed facilities and resources for dispersed users. Therefore, KOCED needed a supporting system not only for research collaboration but for the management and administration of the facilities and services. This system which integrates administration system with collaboration system is called as KOCED CI system.

3.2. Computing Cluster

KOCED CI intends to provide collaboration services specific to the construction engineering community. Since HPC is out of reach, KOCED has chosen a small computing cluster to serve visualization needs, online hybrid testing, and KOCED education grid. Currently it consists of 40 processors with one master node. With time, more processors will be added to the cluster. Moreover, this cluster can be extended to a much larger one by linking with a computing cluster built and operated by Korea Institute of Science and Technology Information (KISTI) through high performance information network called KREONET.

3.3. Data, Information and Knowledge Management Services

One of the main objectives of KOCED Collaboratory is to share data, information, and knowledge with the community. To facilitate the dissemination and utilization of experimental data, KOCED PMC standardized processes and procedures of the experiments, and developed data models for experiments that will be

performed at 6 testing facilities. All of the raw, structured, and processed data will be stored at the central data repository. In order to accelerate the transition from data to information and knowledge, KOCED has developed a simplified structured data model named KOCED Shared Data. This data will be available to the public immediately after completing the experiment. Along with the data models, KOCED PMC also established relevant data policy that stipulates rights and obligations of investigators to their data.

3.4. Collaboration Services

KOCED CI provides many diversified versions of collaboration services such as multi-party bidirectional teleconference, web casting of seminars and experiments, remote control and monitoring, dispersed and collaborative design, online bidirectional lecturing, expert consultants network, etc., At the center of these applications there are two core services: telepresence system and webcasting system (Figure 9). Since KOCED needs production quality services, KOCED PMC procured a customized commercial system. In current capacity, maximum of 30 parties can participate in multi-directional video conferencing with maximum of 12 divided screens. PPT files can be transmitted independently and shared by the participants. An electric board can be used and chatting windows can be activated. On the other hand, webcasting is unidirectional and there is no limit in the number of recipients. One strong advantage of the KOCED telepresence system is that it does not require special equipments other than a web camera per participant.

3.5. Virtual Laboratory

Visualization is increasingly becoming an integral part of teaching and learning. KOCED PMC has developed two virtual experiment models: one is the shake table testing structure model (Figure 10), and the other is the 3-D truss model. Column bases of the structure model can be excited independently. Members can be eliminated or added and member properties can be prescribed and changed. Not only the vibration of the entire model but the vibration of each mode can be visualized as well. The level of member forces will be identified by colors. Time histories of the nodal responses will be provided along with their Fourier transforms. Real data measured with real test models can be fed into the virtual model and the responses can be visualized. The virtual truss model has capabilities similar to the shake table model.

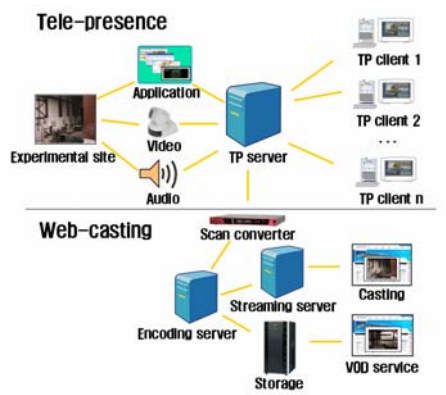


Figure 9 Collaboration services

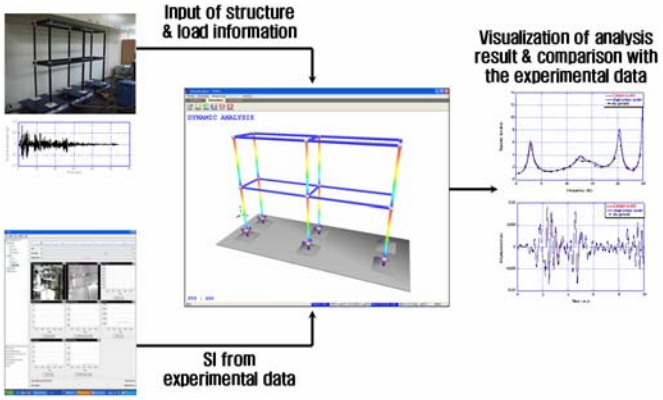


Figure 10 Virtual experiment model

3.6. Education Grid and Other Education-related Services

KOCED is developing a very unique CI called KOCED education grid (Figure 11) which is devoted to teaching and learning both in class and in person. It is independent of the main CI and it itself constitutes a grid system with 6 small sized experiment facilities ranging from desktop shake table, miniature centrifuge, wind tunnel to small portable wave basin. Users can access any facility, perform real time online experiment controlling and

monitoring remotely. This application will eventually be combined with the virtual laboratory capability. In order to enhance teaching and learning, KOCED PMC is developing a collection of courseware in digital and graphic format. This collection of education materials is called e-contents. Presently, education materials on the design of bridges and highways are available online to the general public.

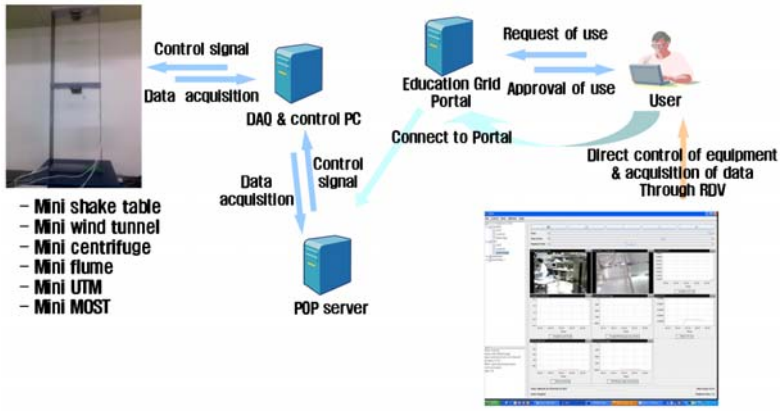


Figure 11 Education Grid

3.7. Online Expert Consulting and Other Services for Industry

KOCED Collaboratory intends to support industry. To this end, KOCED PMC is developing an Expert Consultants Network. It will link individuals or companies seeking assistance from experts about a specific problem with the experts around the world. The two parties can communicate or collaborate online using the KOCED telepresence service. In this era of globalization, the designs can be done very efficiently by using collaboration services and tools. KOCED will provide dispersed collaborative design service to KOCED members.

4. CONCLUSION

In this short article, the experimental facilities and cyberinfrastructure of KOCED Collaboratory is briefly introduced. The main strategy of the KOCED program is planning and building the research infrastructure on the shared-use basis from the beginning, utilizing advanced information and communication technologies. It is expected that KOCED will transform the traditional research and education practices to a much more cost effective and efficient form. Since the goal of civil engineering is contributing to the well being of the public, the collaboration will be the most appropriate way of conducting business in this area of engineering. The ultimate benefactor will be the public. Moreover, the benefits should not be limited 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 regard, 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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