PIARC

LARGE-SCALE RESEARCH FACILITIES FOR CIVIL ENGINEERING AND TRANSPORT

TOOLS FOR STRONGER COMPETITIVENESS WITHIN A SUSTAINABLE DEVELOPMENT FRAMEWORK

Friday 24 October 2003 (8.30 – 12.00 a.m.)

SESSION AGENDA & INTRODUCTORY REPORT

22.45.E

Session Agenda

1. **Introduction**

Mr. Michel RAY (Session Chairperson, EGIS/FRANCE)

2. **TREE (Transport Research for Equipment in Europe) project**

Mr. Alain MALDONADO (Laboratoire Central des Ponts et Chaussées/FRANCE)

3. **Competitiveness of the TREE network**

Mr. Alain MALDONADO (Laboratoire Central des Ponts et Chaussées/FRANCE)

4. **Scientific co-operation between researchers and equipment in Japan**

Dr. Hirofumi OHNISHI
(National Institute for Land and Infrastructure Management/JAPAN)

Discussion

5. **Video CD-ROM Physical modelling with using Geotechnical centrifuge**

6. **Measurement and Testing**

Mr. Alain MALDONADO (Laboratoire Central des Ponts et Chaussées/FRANCE)

7. **The modelling Function of researcher facilities dedicated to civil engineering and transportation application**

Mr. Alain MALDONADO (Laboratoire Central des Ponts et Chaussées/FRANCE)

Discussion

8. **Conclusion and closure**

Mr. Michel RAY (Session Chairperson, EGIS/FRANCE)

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ABSTRACT

As part of the 5th Framework's GROWTH programme, the European Union has authorised the LCPC (French Public Works Research Laboratory), a national research centre focusing on the fields of civil engineering and transport in France, and the CETRA (Centre for Transportation Research) of the University of Žilina (Slovakia) to coordinate two projects known by their acronyms as "TREE" (Transport Research for Public Works in Europe) and "INTRANSNET" (Network of European Medium- and Large-scale Research Facility Operators). These projects constitute two thematic networks that serve to mobilise, each in a different manner, the set of civil engineering and transport research equipment currently available throughout both the European Union (EU) and the Central and Eastern European countries (CEEC). AIPCR/PIARC has provided the opportunity to host a roundtable session and present these two research networks at the occasion of an extraordinary gathering of experts in the field of road and transport engineering. The objective of this roundtable is to: broaden researchers' scope of intervention, facilitate exchanges of expertise and information at the regional level worldwide, and take account of socio-economic and environmental requirements while increasing corporate competitiveness.

The report presented herein will set forth, in summary fashion, the following:

- the rationale that generally prevails during construction of the facilities contained within these networks;
- the scientific and technical resources along with the equipment made available to both researchers and companies;
- the assets these networks are capable of mobilising in order to meet the needs of a European and worldwide scientific / technical environment in a constant state of change;
- results from the initial exchanges held to prepare this roundtable session.

During the roundtable, samples of work carried out using specific research equipment will be on display. The intended goal is not merely to highlight the diversity and complexity of the studies made possible thanks to these facilities, but also to identify new investigation approaches and support efforts in conducting cross-participatory actions between research teams.

DESCRIPTION OF THE TREE AND INTRANSNET NETWORKS

The research institutes involved with the TREE and INTRANSNET networks (see Table 1) exhibit distinct entity statutes. Included herein would be: universities, laboratories funded by the Ministries of Public Works and Research, independent scientific and technological institutes, design offices and industrial and commercial companies. In addition, the TREE Network hosts an association with a European status, FERHL (Association of European laboratories), and two European decision-making clubs: FERSI (Institutes concerned with road safety issues in Europe) and WERD (European Road Directors). The aims of both TREE and INTRANSNET encompass:

- production of catalogues combining the various research equipment available within the civil engineering and transport fields in Europe;
- determination of a European strategy to ensure continuation of their development beyond the Commission-funding period;
- implementation of an integrated system that features research and logistics equipment applicable to all means of transport.

Table 1: Comparison of the TREE and INTRANSNET networks

Project (pilot)	Logo	Partners	Specialization
TREE (LCPC)	LCPC Laboratoire Central des Ponts et Chaussées Driving research across networks	FEHRL, KUSS, FINNRA, CDV, VTI, ARSENAL, BAST, DWW, INRETS, VTT IBDiM, CEDEX, TRL, NTUA, SITIA, FERSI, WERD	The network's basis relies upon the group of road engineering laboratories within the Ministries of Public Works of the participant European countries.
INTRANSNET University of ŽILINA (CETRA)		CETRA, FGM, VY, IBERINSA, TUD, DRL, TUW, ERRI, UGHK, SSPA, SUT, AUCHA	This network comprises universities and companies specialized in logistics and data processing.

A rapid inventory reveals that the TREE and INTRANSNET networks can provide researchers and companies with different types of equipment (see the following non-binding list):

- Industrial process pilots
- Centrifugal machines intended for geotechnical studies
- Gyrator gears for studying road structures
- Tensioning and relaxation benches for cables
- Dynamic vibration and loading benches
- Benches for structural studies
- Ventilation tunnels with controlled temperature
- Hull basins
- Mobile laboratories equipped with measurement sensors or robots
- Fog simulation rooms for visibility-related studies
- Control mixing test stations
- Testing equipment for aggregates
- Simulators of various types of vehicle-driving behaviour
- Simulation and computer centres, fitted with specific computing codes
- Crash testing tracks
- Materials testing facilities

Let's recall at this point that the purpose of research equipment is:

- to produce actions and various controlled constraints on physical models, reduced-size objects, structural elements, based either on theoretical models or simulation results in order to examine the evolution of built facilities;
- to conduct measurements on physical models (structural elements and materials) in order to design constitutive laws;
- to interpret the variables measured on test benches using computational tools in order to limit construction costs;
- to study deterioration modes and the risks inherent in the various facilities;
- to validate studies carried out prior to *in situ* measurements.

The TREE and INTRANSNET networks are designed to foster knowledge acquisition, experimental efforts and individual expertise; they both have the capacity to make use of analogous technical and scientific approaches. Their goal is to ensure the functions of measurement, modelling and simulation. The environment likely to be studied when implementing research equipment however is often difficult to qualify. Let's recall, for example, that in the field of the civil engineering, measurements pertain to physically-heterogeneous environments. The masses and volumes involved in these studies can vary over ranges of several thousands of tons, hundreds of cubic meters and a few cubic decimetres. The dynamic phenomena being targeted (landslides or earthquakes) may occur either very slowly or suddenly and in unforeseeable ways. These phenomena cannot be studied by means of setting up preliminary instrumentation.

Modelling entails applying physical and mechanical laws in order to derive a sound model; it enables establishing relations between data (measurements) and system states. When the modelling operation results from series of measurements, so-called "knowledge models" are obtained. Modelling functions via the representation of equivalence classes, including similarities (reduced model) and analogies; it can reveal, in the form of abstraction and reduction, the relational ties between situations belonging to separate and distinct fields. According to the nature of the problem arising or in the presence of a complex system, different research equipment may be called upon. The use of digital models has become widespread thanks to the development of computational resources; such models now allow, depending on the specific set of needs, addressing a wide array of issues, as exemplified by the following:

- the action of road traffic;
- environmental impacts of air traffic;
- the action of mechanical or hydraulic loads exerted upon structures;
- landslide movements;
- the effects of water table rise during flooding.

Once measurement and modelling have been performed, the simulation function constitutes the third component within the range of possibilities inherent in large-scale research equipment. Simulation programmes study the behaviour of several associated or coupled models submitted to constraints and yield a summary result. Some simulations take advantage of the possibilities proposed by imaging techniques. In this case, the operator (researcher) is able to utilize the processing speed and execution flexibility offered by new data-related technologies. Due to the diversity of the phenomena being reproduced, simulation can serve different purposes, among which: studies that enable designing virtual prototypes to determine responses to various types of loadings, training to facilitate decision-making within the framework of complex situations, and scientific investigations that serve to monitor processes not easily observed due to either their duration, distance or size.

CONTRIBUTIONS AND APPLICATIONS OF THESE NETWORKS

Some selected (and original) examples will be presented during the roundtable session. We will convey how the technical, scientific and economic contributions of the TREE and INTRANSNET networks could benefit a broad array of distinct projects. These networks have not at all been confined to the study of materials and structures; they have also played a role in European competitiveness and in enhancing the renown of the national organisations involved. We are thus able to identify contributions in the following areas:

- industrialisation of manufacturing methods in the field of civil engineering;
- management of transport flows in response to mobility needs;
- optimisation of natural resource use;
- crisis and risk management;
- standardisation;
- training and information contributing to the dissemination of new techniques.

The expanding use of digital control commands in manufacturing processes has, for example, led some of these tests centres to study the means by which complex assemblies can be run; such approaches would include devices operating in both series and parallel. As a result of this trend, the concepts of optimal operating point and regulation around this point have been developed. Studies have then made it possible to promote the use of non-conventional materials in various road networks that take the needs for servicing certain zones into account.

Research equipment could be used for validating certain construction choices as well. Without being limited to studying just the physics of the phenomena, these instruments also facilitate incorporating the potential of certain risks. In this aim, methodologies have been developed to better define the risks associated with a given construction project. Two complementary steps have attracted the attention of researchers: the deterministic method and the probabilistic method.

TREE and INTRANSNET network equipment, when first installed, provided European Member States with the possibility of shaping doctrines regarding road construction, regional planning and transport. Creation of the single European market lies at the origin of new demands placed upon this equipment, i.e.: conducting cross-testing in order to homogenise practices at the European level and elsewhere, developing relations between researchers, and sharing data to obtain a truly-European added value.

All laboratories within the TREE and INTRANSNET networks enjoy links with the academic world. In France, special relations have also been forged with engineering schools. Directors of Research are generally responsible for providing training courses both at the university level and within engineering schools. Research institutes host students attending training courses and oversee Ph.D. thesis projects. The work conducted is validated via publishing dissertations and awarding doctorate degrees.

NEW PROJECTS, SYNERGIES AND CROSS-PARTICIPATION

Under this heading, some potential study topics will be discussed; these will require the development of new concepts and are to specifically challenge researchers over the coming years. The goal herein is: to provide a response to the accelerating pace of change undergone within industry, to accompany technological change more effectively, to prevent accidents and environmental disasters, and to better control the factors causing the anxiety felt in modern society? Among these topics, the following are worth citing:

Integration of environment-related concepts. An industrial Quality policy is typically a process stemming from a rationale aimed at ongoing improvement. The presence of such a policy can be observed even when the original focus concerns satisfying product standards. The concept of quality however extends gradually and more globally to protection of the environment. In this case, it is absolutely necessary to create new reference benchmarks and integrate them into industrial strategies that include data whose source of control may be missing. Animal migration would provide an appropriate example. In this instance, research networks can offer meaningful contributions by associating various complementary competences.

Modelling the driving task. In the opinion of experts, the task of automobile driving seems to allow for modelling possibilities according to several levels of complexity, which take into account the tasks of vehicle trajectory control, situation resolution and global navigation and orientation within existing traffic patterns. The driving task also entails a notion of activity determined from the knowledge, representations and attitudes acquired with experience; it is also necessary to incorporate the entire extent of behaviour-related psychomotor skills, i.e. reflexes, cognitive functions in searching relevant information and in particular the decisional activity performed by the motorist. Like other human activities, automobile control revolves around both individual and collective social activity. Some laboratories propose assessing the possibility of using large-scale equipment to study driver behaviour within a variable physical environment. The aim herein is to adopt measures that serve to limit the long-term risks of accidents.

Economic and social cohesion. Research equipment also acts as a factor of economic and social cohesion. Let's recall for example that all moves towards European expansion have been accompanied by the implementation of economic and structural conditions among newly-entering countries as well as existing European Union Members. Such equipment provides scientists the opportunity to validate computation methods, establish construction standards, homogenise methods and means of communication at the European level, and initiate training programmes to facilitate knowledge dissemination (see the TREE and INTRANSNET Web sites).

CONCLUSION

Several observations stand out at this stage.

The first pertains to the representativeness of both the TREE and INTRANSNET networks. By combining entities with highly different organizational statutes across all EU countries, these two networks effectively address sector-specific research activities in civil engineering, roads and transport at the European level.

The second observation takes account of the economic, social and environmental concerns of these two networks: they contribute to generating "Sustainable Development" policy guidelines that show attentiveness and respect for culture in all areas of the world.

Third observation: TREE and INTRANSNET can instil confidence in companies by becoming involved in their micro / macroeconomic and environmental preoccupations. As regards the issues of employment, safety and quality-of-life enhancement, these networks contribute to facilitating high-level decision-making. This technical, scientific and economic step is not devoid of an ethical approach when focusing on the projected evolution of societal needs, as reflected in the Charter provided below:

The objective of the TREE project is to develop a virtual laboratory that contains large-scale equipment for civil engineering and transport research. The project is funded by the European Commission and is part of the Fifth Framework's Growth programme.

TREE aims to offer a wide choice of equipment to those undertaking or commissioning research in order to:

- *contribute to the competitiveness of the European Union within the global marketplace,*
- *harmonise procedures within the European Union to facilitate enlargement and contribute to Member States' increasing influence in the world.*

TREE partners are to committed to:

- *the aims of Sustainable Development*
- *encouraging new partners to join the network*
- *collaboration with one another*
- *the development of science and technology in their fields of expertise.*

TREE Web site: www.TREE-TRANSPORT-FACILITIES.net
INTRANSNET Web site: www.INTRANSNET.sk