European Cooperation in the field of Scientific and Technical Research
- COST -

Secretariat

Brussels, 11 July 2006

COST 279/06

MEMORANDUM OF UNDERSTANDING

Subject : Memorandum of Understanding (MoU) for the implementation of a European Concerted Research Action designated as COST Action E55 'Modelling of the performance of timber structures'

Delegations will find attached the Memorandum of Understanding for COST Action E55 as approved by the COST Committee of Senior Officials (CSO) at its 165th meeting on 27/28 June 2006.

MEMORANDUM OF UNDERSTANDING
For the IMPLEMENTATION OF A EUROPEAN CONCERTED RESEARCH ACTION DESIGNATED AS

COST Action E55

'Modelling of the performance of timber structures'

The Signatories to this 'Memorandum of Understanding', declaring their common intention to participate in the concerted Action referred to above and described in the 'Technical Annex to the Memorandum', have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 400/01 'Rules and Procedures for Implementing COST Actions', or in any new document amending or replacing it, the contents of which the Signatories are fully aware of.

2. The main objective of the Action is to provide the basic framework and knowledge required for the efficient and sustainable use of timber as a structural and building material.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at approximately EUR 26 million in 2006 prices.

4. The Memorandum of Understanding will take effect on being signed by at least five Signatories.

5. The Memorandum of Understanding will remain in force for a period of four years, calculated from the date of first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in Point 1 above.

COST Action E55

Modelling of the Performance of Timber Structures

A. ABSTRACT

The safe and sustainable use of materials in construction necessitates that the life-cycle performance of structures can be predicted and reassessed with sufficient accuracy. Recent research achievements in the field of materials science and structural reliability provide a framework for the quantification of safety, durability and life-cycle costs of structures. These achievements are so far mainly used in the field of concrete and steel structural engineering. The knowledge about the behaviour of timber materials and structures is still considered as being insufficient for its use in such a framework.

The main objective of the Action is to provide the basic framework and knowledge required for the efficient and sustainable use of timber as a structural and building material. The objective of the Action will be achieved by building on three main research activities: the identification and modelling of relevant load and environmental exposure scenarios, the improvement of knowledge concerning the behaviour of timber structural elements and the development of a generic framework for the assessment of the life-cycle vulnerability and robustness of timber structures. The Action serves as a development platform for the European timber engineering research community to improve the knowledge about the life-cycle performance of timber structures.

Keywords: timber structures, life-cycle performance, safety, serviceability.

B. BACKGROUND

Timber is an efficient building material, not least in regard to its mechanical properties but also because it is a highly sustainable material considering all phases of the life cycle of timber structures: production, use and decommissioning. Timber is a widely available natural resource throughout Europe; with proper management, there is a potential for a continuous and sustainable supply of raw timber material in the future. Because of the low energy use and the low level of pollution associated with the manufacturing of timber structures the environmental impact is much smaller than for structures built in other materials. In addition, timber is a rather advantageous building material because of its material properties. Timber is a light material and compared with its weight the strength is high; the strength:weight ratio is even higher than for steel.

However, considering its beneficial properties, timber is still not used to its full potential in the building and construction sector. Many building developers, architects and structural engineers do not consider timber as a competitive building material compared with concrete, steel or masonry. Attributes such as high performance regarding reliability, serviceability and durability are generally not associated with timber as a building material. One of the main reasons for this is that timber is a highly complex material; it actually requires a significant amount of expertise to fully appreciate the potential of timber as a structural building material. There are also a number of issues which need to be further researched before timber materials can achieve the same recognition as a high quality building material such as steel and concrete. These issues are the focal point of this Action.

In daily practice, engineering codes and regulations form the premises for the use of timber as a structural material. It is therefore of utmost importance that the codes and regulations are based on the most relevant and exact information available regarding the performance of timber structures. Traditionally, codes and regulations have been based to a very large degree on experience. This statement is true not just for timber structures but also for concrete and steel structures. However, whereas the codes and regulations for the design of concrete and steel have undergone a remarkable modernisation over the last two to three decades, codes and regulations for the design of timber structures are falling significantly behind. The principle for the development of the scientific basis for codes and regulations for the design and assessment of structures is illustrated in Figure 1.

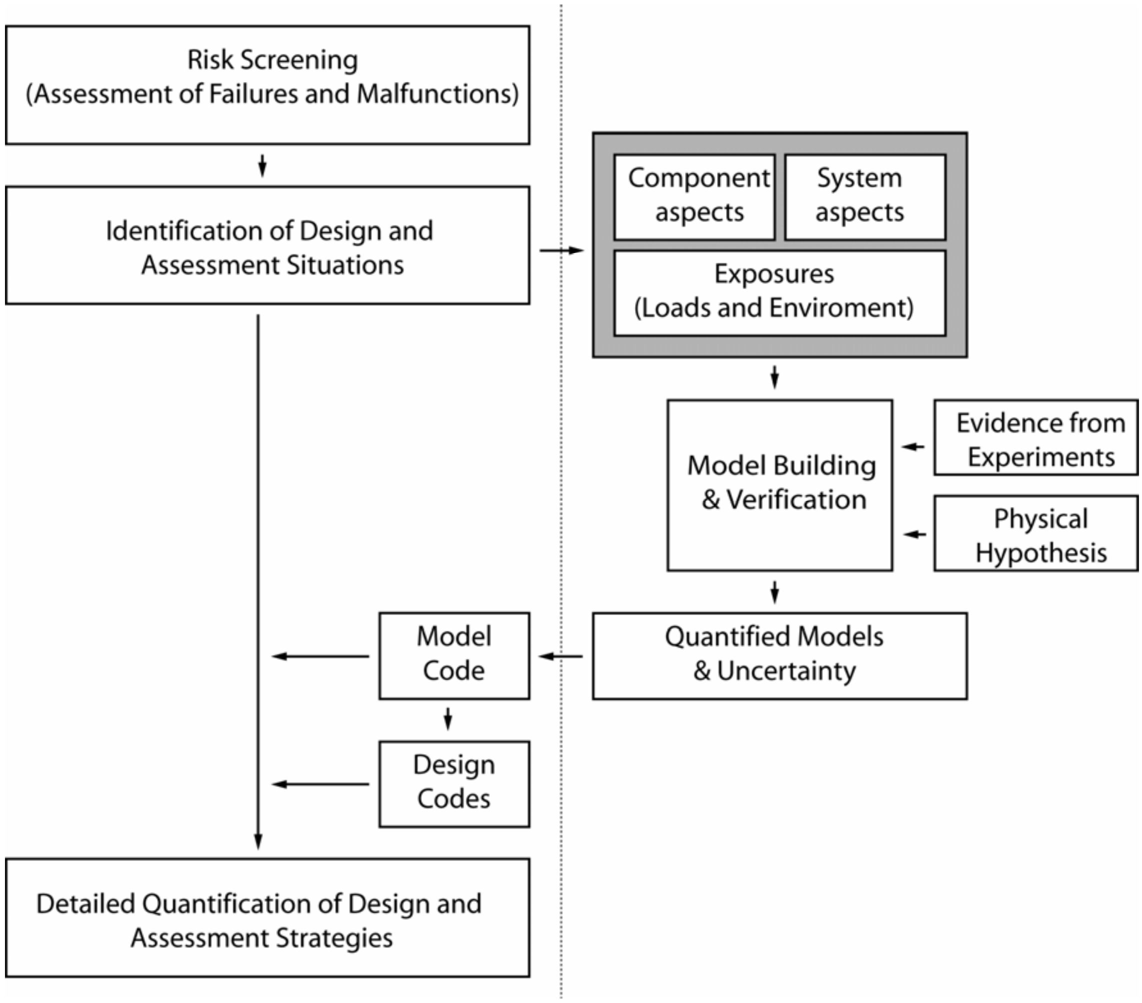

Figure 1. Schematic representation of the framework required for establishing the basis for codes and regulations for design, assessment and maintenance of structures.

Whereas the various steps in the process of developing a basis for design and assessment are illustrated to the left in Figure 1, the scientific constituents required in the process are illustrated in the right part of the figure. Currently, the existing codes and regulations for the design of timber structures are not fully based on a framework as illustrated in Figure 1, but rather on a framework having its basis in a general physical understanding combined with experience achieved over hundreds of years of using timber as a structural material. In order to achieve the goal of optimising the potential benefit of timber as a building material it is therefore necessary to establish a firm scientific basis for codes and regulations according to the process indicated in Figure 1.

Several initiatives in this direction have been undertaken especially within the last 10 years. One of these, namely COST Action E24 'Reliability of timber structures', also followed the process indicated in Figure 1 as a basic working thesis, even though somewhat implicit. The main outcomes of COST Action E24 are related to necessary pre-codification modelling aspects concerning the performance of timber components regarding strength and stiffness properties. A very successful achievement of that Action is that the work performed is fully compatible with the general probabilistic framework for establishing a design basis developed by the Joint Committee on Structural Safety (JCSS).

However, during the course of the COST Action E24 it became apparent that several fundamental issues require more research and development. In particular it was found that the present practice regarding quality control strategies for raw and engineered timber introduces significant uncertainties in the performance of timber structural components. Furthermore, as another example it was found that model uncertainties associated with high performance timber structural components, such as glued laminated timber beams, are unsatisfactorily high. In addition to these significant deficiencies, several important steps in the process illustrated in Figure 1 are still not covered sufficiently.

More than for other building materials, the properties of timber structural components and systems have to be seen in relation to the loads and the environment to which timber structures are exposed. Adverse effects in timber structures are not only related to critical load-strength combinations but rather to moisture-induced strength and stiffness degradation of structural elements and connections. An important mechanism behind that is the so-called 'mechano-sorptive' creep of timber and also degradation as a consequence of physical and/or biological decay (insects/fungi). Several research activities in the field of moisture effects in buildings have taken place, but the individual contributions did not converge to a general consensus which could form a scientific basis for proper code formats and regulations facilitating engineers to cope with the problem in daily design and maintenance.

It is aim of this Action to:

- ensure that the focus of the European structural timber research community will be directed to the current issues of special importance for the industry, as well as pre- and normative efforts to enhance the use of timber as a competitive and sustainable building material;
- facilitate continued efforts directed to research on topics which were identified as most important during the lifespan of COST Action E24 (quality control/grading, glued laminated timber, model uncertainties, etc.);
- initiate the important development of a consistent basis for the assessment and condition control of existing timber structures (identification of the most important degradation mechanisms, modelling of the significant exposures relating to degradation, quantitative modelling of inspection results);
- specifically address concerns raised in connection with the recent events of failure of timber structures as concerns robustness, effects of degradation and efficient means for condition control;
- facilitate improved exchange of research results and data as well as providing a platform for young researchers for enhancing their research through the development of inter-European research networks.

The Action will build on the achievements of existing and past European as well as international work in the field and will benefit from synergies with current research activities. In this respect the following expired and ongoing COST Actions are of particular relevance:

COST Action E2 Wood durability (completed in 1999)
COST Action E8 Mechanical performance of wood and wood products (completed in 2000)
COST Action E24 Reliability of timber structures (completed in 2005)
COST Action E29 Innovative Timber & Composite Elements (running)
COST Action E53 Quality Control for Wood and Wood Products (recently started).

Codes and regulations relevant for the use of timber as a structural and building material.

It is of crucial importance to ensure that the work of the Action is integrated and coordinated with pre-normative and normative works performed in the sector. Therefore the Action will closely cooperate with the:

- Working Group for Timber Structures of the international Council for Research and Innovation in Building and Construction (CIB W18)
- ISO Technical Committee for timber structures (ISO TC165)
- International Association for Building Materials and Structures (RILEM)
- Joint Committee on Structural Safety (JCSS)
- CEN Technical Committee for drafting European standards for timber structures, (CEN TC124)
- CEN Technical Committee for drafting Eurocode 5 – Timber Structures (CEN TC250).

Existing European cooperation in the areas mentioned above provides a strong starting point for the implementation of the Action. Cooperation with leading non-COST countries in this field (North America, Australia and New Zealand) will be initiated.

In Europe several national, interregional and inter-European research projects directly or indirectly concerned with subjects related to this Action have been initiated recently and more are envisaged. The COST framework offers an excellent basis for the coordination of these activities and will provide a platform for the targeted joint effort necessary for ensuring that timber will be used to its full potential as a sustainable building material.

C. OBJECTIVES AND BENEFITS

Objectives

The main objective of this Action is to provide the basic framework and knowledge required for the efficient and sustainable use of timber as a structural and building material. Focus is directed on the aspects of design, construction, assessment and maintenance of competitive and high performance timber structures. The Action mainly considers high performance structures where the load-bearing capacity is of predominant interest; for example, structures such as timber bridges, large-span halls and roofs, and also load-bearing elements of other types of timber structures.

The specific objectives of the Action are:

- to improve the understanding about typical design and assessment situations as well as the circumstances, including exposure conditions leading to inadequate performance;

- to provide guidelines on how to assess relevant exposures and to represent these in a format suitable as a basis for the design of high performance timber structures including aspects of moisture-related degradation;
- to improve the fundamental understanding of timber material and engineered timber products, such as glued laminated timber, as well as the understanding of connections for efficient and reliable use in production and service;
- to assess robustness and system aspects for timber structures;
- to develop risk management and control methods for timber structures.

Long-term objectives; based on the theoretical and methodical achievements developed during the Action:

- to establish a rational basis for the design and assessment of timber structures ensuring that the full potential of the use of timber material as a sustainable construction material may be used for the benefit of the timber industry and society in general;
- to provide a basis for assessing the real need for targeted future research activities regarding the service-life aspects of high performance timber structures.

Benefits

- Improving design methods, assessment techniques and maintenance policies for timber structures.
- Creating a knowledge pool for timber as a high performance material.
- Improving the competitiveness of timber and timber products.
- Increasing the use of timber in high performance structures.
- Contributing to a more efficient and sustainable use of forest resources in the European building sector.
- Providing the engineering community with a modern probability based foundation for the efficient performance-based life-cycle design and assessment of timber structures.

D. SCIENTIFIC PROGRAMME

To ensure the achievement of the objectives, the work within this Action is divided into three working groups (WGs):

WG1: System identification and exposures
WG2: Vulnerability of components
WG3: Robustness of systems

The main tasks of the different working groups are specified as follows:

WG1. System identification and exposures

An important issue of this working group is the collection and the assessment of failures and malfunctions of timber structures on a European scale. Based on these observations possible gaps and shortcomings in current design and maintenance strategies will be identified and reflected in future considerations. Besides the observations and analysis of failures and malfunctions the theoretical aspects underlying different design and assessment situations will also be discussed in WG1.

Specifically the following aspects will be considered in WG1:

- Collecting information about failed or malfunctioning timber structures.
- Analysis of the mechanisms leading to failure and malfunctioning.
- Identification and representation of relevant exposures for the purpose of design and assessment.
- Identification of relevant design and assessment situations, including the identification and mapping of the relevant degradation mechanisms for Europe.

WG2. Vulnerability of components

The consideration of the lifetime performance of a timber structure is based on basic models about the relevant aspects of the structural components and connections. These aspects are:

- Basic strength and stiffness properties of graded timber material, glued laminated timber and related products.
- Dependency of these properties on load and climate scenarios which might occur during the lifetime of the structure, and size dependencies.
- Strength and stiffness properties of connections over service-life.
- Modelling of moisture-related degradation and service-life assessment of timber components and connections.

As found in COST Action E24, the underlying models and procedures used in practice do not consistently account for the uncertainties associated with the used models and the available experimental evidence. The focus of WG2 is to reassess and refine the present practice of modelling, especially for the important situations identified by WG1.

The development of service-life assessment models for moisture-related degradation of timber structures is still in a very early stage as compared with the situation for concrete and steel. To date no quantitative model for the deterioration of wood is implemented in the design codes. Based on the relevant degradation mechanisms identified by WG1, models for the most important of these will be suggested and quantified by WG2.

WG3. Robustness of systems

An important aspect for the assessment of the life cycle performance of timber structures is the interaction of structural components in structural systems. System effects in timber structures are pronounced because of multiscale spatial variability of environmental exposures and material properties. Existing numerical methods used to assess the reliability of timber structures need to be evaluated for their possible application to timber systems, and simplified approaches suitable for day-to-day engineering purposes must be identified. Furthermore, consensus on the general characteristics of timber systems regarding redundancy and robustness has not yet been established. To reach a better understanding of these aspects the following activities are planned within WG3:

- Characterisation of multiscale variability in timber structures.
- Analysis of system effects for several types of timber structures.
- Qualification of robustness as a characteristic of timber structures.
- Establishing a framework for reliability based design and assessment of timber structural systems based on these considerations.

E. ORGANISATION

The COST Action will be led by a Management Committee (MC). Responsibility for detailed planning, execution and documentation of the individual activities will be delegated by the MC to a Steering Group (SG), consisting of the chairperson of the COST Action, the vice-chairperson, the working group coordinators and, when necessary, others through appointment by the MC. Where possible, the MC or SG meetings will be organised in connection with WG meetings, workshops and conferences to minimise the costs involved in the coordination of the COST Action.

The main activities of the COST Action are to be carried out at the WG level. The WGs will act as links between the COST Action and existing research programmes, and will be the fora for intensive interactions between the industry and the research community. WG meetings for sub-groups or for the entire WG will be organised as and when required within individual activities. Exchange visits of scientists, especially young scientists, within the short-term scientific mission scheme will be encouraged by the MC to foster collaboration between institutions, laboratories and industries of COST countries.

The three WGs are closely linked to each other. To provide the key information from within the WGs to the MC of the COST Action, and to stimulate the interactions between the WGs, two or three workshops or seminars will be organised. These workshops/seminars may include a one-day session for each of the WGs, which will run in parallel, followed by a one-day plenary session.

In addition, this Action will make use of the Training School-scheme for the training of both industrialists and academics that are interested in various aspects of modelling of the performance of timber structures. This sector is a technological one and so it changes rapidly in terms of the methods used to plan projects and control products, and legislation. At the same time, this instrument can help disseminate information emerging from this Action.

At a midterm conference and a final conference the results of this COST Action will be presented to a broader audience. These conferences may be organised in connection with established international conferences.

F. TIMETABLE

The duration of the Action is four year. The time schedule for various activities is shown in Figure 2.

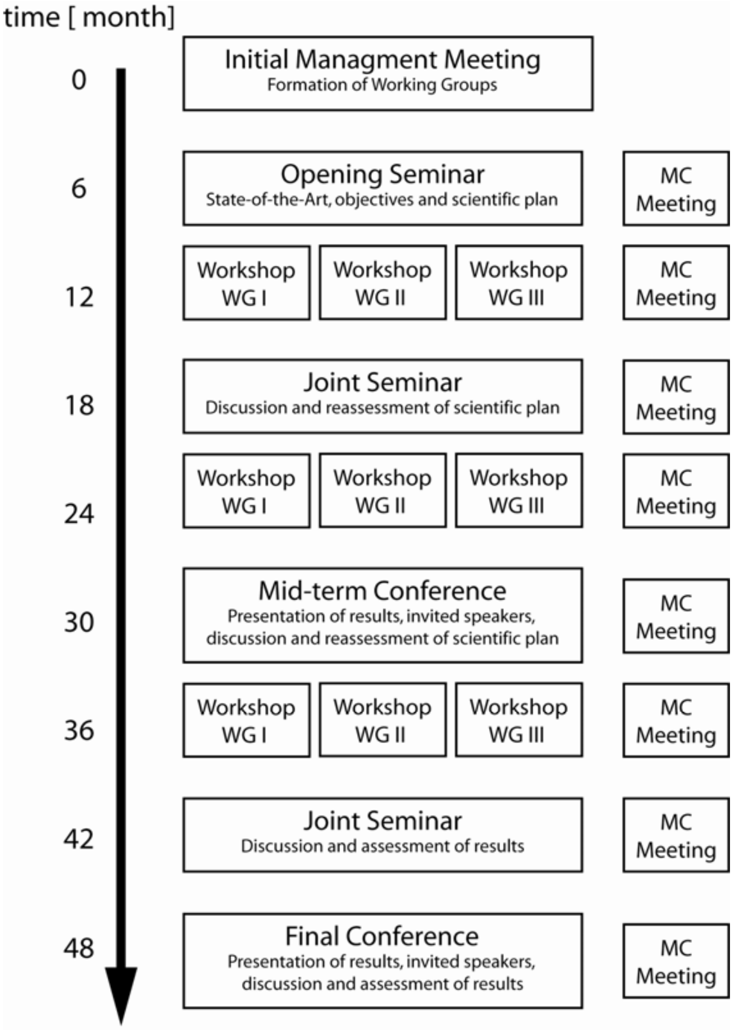

Figure 2. Organisation and preliminary timetable of the main activities

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest:

Austria Belgium, Croatia, Czech Republic, Denmark, Finland, Former Yugoslavian Republic of Macedonia, France, Germany, Hungary, Ireland, Italy, Lithuania, Netherlands, Norway, Portugal, Romania, Slovenia, Spain, Sweden, Switzerland,, United Kingdom

On the basis of national estimates provided by representatives of these countries the economic dimension of the activities to be carried out under the Action has been estimated, in 2006 prices, at approximately EUR 26 million.

This estimate is valid on the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

As indicated in the time schedule, the Management Committee will organise workshops and seminars. These meetings will promote interdisciplinary research in the fields of wood science and technology, timber engineering and structural reliability. Opportunities will be explored to link the planned conferences with CIB W18, ISO TC165, CEN TC124, CEN TC250, JCSS and RILEM workshops/conferences where relevant and possible. Co-authored papers as well as dissemination of research findings at international conferences will also be encouraged.

Another efficient tool for the dissemination of activities is the Internet. The construction of a web page devoted to the Action and the application of research findings will be included in the dissemination programme. Case studies will be presented, in order to clarify the new concepts explored during the Action.

Finally, the findings of this Action will be compiled into one document which delivers the basic research results .The document will also contain recommendations to support the design engineering community with proper design methods, enhancing the use of timber as a sustainable high performance building material.

All publications arising from the research carried out under this COST Action will give credit to EU support.