Presentation of COST Action C25

Sustainability of Constructions
Integrated Approach to Life-time Structural Engineering

Luis Bragança – C25 Chairman

University of Minho
Portugal

MALTA – Sustainable Construction 2010

COST Action C25 - Facts

- Start date: 12/12/2006
- End date: 11/12/2010
- 28 countries and 1 EU Joint Research Centre involved
- Since the beginning of the Action, 128 persons participated in at least one meeting, billing:
  - 108 persons members that participate regularly
  - 32 females, corresponding to 30% of the members
  - 31 Early Stage Researchers, corresponding to 29% of the members
  - 32 Invited Experts that participated in at least one meeting
- So far, 8 STMS:
  - 2 items are approved by the MC but not yet taken place;
  - 5 more are under preparation.
**Topic: “Sustainable Engineering”**

- Integrated approach to deal with the end-products of construction
- Targeted at the development of R&D and Engineering methods from structural points of view
- Methodologies that incorporate holistic understanding on the integrated processes and systems
- Structural engineering is beginning to develop an integrated design approach in which advanced tools are used to analyse and verify the various performance aspects and sustainability demands.

**State-of-the-Art**

- Construction Life Cycle Analysis is a valuing process whose comprehension and usability in practice requires science-based systemic approach
- Assessment methods and tools need clear and practical guidance on valuing processes
- Incorporation of all dimensions of sustainable construction to assessment procedures magnifies problems of a multicriteria decision-making

**Background**

- The construction sector consumes about 50% of all resources taken from the Earth, a percentage that is more than any other industrial sector
- The construction, operation and subsequent demolition of all built facilities accounts for about 40-45% of all energy end use
- The built environment accounts for about 40% of the total world greenhouse gas emissions
- Construction is one of the sectors that causes more negative impacts on environment and have more interaction with human live

**State-of-the-Art**

- Sustainability assessment methods and tools on the market and in academia should be comparable and understandable
  - in general: country-specific, difficult to compare and use, data difficult to achieve, system boundaries difficult to define, real life-time not known
State-of-the-Art

- Design methods should be integrated with other modelling tools such as quantity surveying, energy simulation and simulation-based tools
- Methods for service-life design including aspects of maintenance are developing and need to be combined with structural design
- Standardisation (CEN TC 350 and ISO/TC 059)

Aims of COST Action C25

- Research and do collaborative analysis of results concerning design, assessment methods and tools, advanced materials and technologies as well as construction processes, both for new constructions and the rehabilitation of the existing ones
- Focused on an integrated approach to deal with the end-products of construction, clearly targeted at the development of R&D and engineering methods from structural point of view

Aims of COST Action C25

- Promote a scientific understanding of life-time engineering
- Boost science-based advancement of sustainable construction in Europe
- Provide the construction sector with a new framework and ideas based on the integration of approaches and results of ongoing research and development projects
- Establishment of a broad network of European universities and other research centers in the field of structural engineering in order to transfer the state-of-art of technologies, design methods and practices through the existing and new links of members of the Action in several international organizations

Main objective

- To promote science-based developments in sustainable construction in Europe through:
  - the collection and collaborative analysis of scientific results concerning
    - life-time structural engineering and especially
  - the integration of sustainability assessment methods and tools for structural engineering
Life-time Structural Engineering

- Aims to ensure that the requirements of stakeholders of the sector are fulfilled in technical terms during the whole life-cycle of a building or structure
- It is an integrated approach to design, building, maintenance, renovation and demolition of constructions
- It is an essential part of sustainable construction

Integrated approach

- Benefits from several theoretical disciplines to produce methods and tools for R&D & I
- Integrated research in “sustainability science”
- Integrated development in “innovation process”
- Integrated practices for “performance-based design”

Structural engineering is beginning to develop an integrated design approach in which advanced tools are used to analyse and verify the various performance aspects and sustainability demands

Secondary Objectives

- To share and harmonize the knowledge of different research teams
- To coordinate European research efforts and thus add more value to individual results
- To publish scientific collaborative papers in international journals
- To gain initiatives for European projects for innovative new construction technologies
- To provide the end-users and other stakeholders with more objective measures for comparisons of alternative solutions

Scientific Research

- Sustainability assessment methods
  - e.g. reliability of data, handling of uncertainty, system analysis, decision-making theories, integration of social and human sciences, input to the development of mixed and interdisciplinary R&D methods
- Technologies and processes to improve eco-efficiency
  - e.g. data mining and data analysis on clean and green technologies, modelling and simulation of material and energy flows in production and use of constructions, sustainable innovation theories, whole-building performance
Scientific Research

- Phenomena affecting service-life of constructions
  - e.g. modelling and simulation of phenomena affecting structural service-life (durability, degradation, fatigue, protection, maintenance - components and systems), risk analysis

- Life-time structural engineering
  - e.g. methods to integrate knowledge from various disciplines, design methods, safety and security aspects in service-life design

Scientific approach

- **Criteria for sustainable constructions**
  - global methodologies, assessment methods, global models and databases

- **Eco-efficiency**
  - eco-efficient use of natural resources in construction (materials, products and processes)

- **Life-time structural engineering**
  - design for durability, life-cycle performance, including maintenance and deconstruction

The methodology to carry out the Action and achieve a coordinated outcome is a case-study approach

Coordination of C25

**MC - Management Committee**
- Chair - Luis Bragança
- Vice-chair - Hei Koukkari

**WG1 - Criteria for Sustainable Constructions**
- Chair - Rijn Blok
- Vice-chair - Helena Gervasie

**WG2 - Eco-efficiency**
- Chair - Milan Veljkovic
- Vice-chair - Zbigniew Płewa

**WG3 - Life-time structural engineering**
- Chair - Raffaele Landolfo
- Vice-chair - Victor Ungureanu

Website and Databases server
- Responsible - Luis Simões da Silva

WG1 - Criteria for Sustainable Constructions
Global methodologies, assessment methods, global models and databases

- **WP1 - State-of-the-art on LCA and LCC methodologies as applied in participating countries**

  *State-of-the-art, with references to previous documents*

- **WP2 - Collection of information on databases of LCI and LCC for construction materials, construction products and processes and assessment of existing data and criteria**

  *Datasheets about databases for LCI and LCC, report describing the need for further development as well as links to available databanks*

- **WP3 - Life-cycle performance: deterministic and stochastic simulation models**

  *Report on models to assess life-cycle performance*

- **WP4 - Implementation of global methodologies for Sustainable Design and Building – case-study**

  *Case-study publication on implementation of methodologies*
**WG2 – Eco-efficiency**
Eco-efficient use of natural resources in construction - materials, products and processes

- **WP5:** Identification and evaluation of existing and new functional materials, construction products and processes to comply with decrease of material use, decrease of waste, decrease of emissions and energy saving goals.
  - Reports and datasheets aiming at recommendations and collaborative papers

- **WP6:** Improvement of environmental performance of constructions (civil engineering structures, building structures and building envelopes), improvement of the comfort in buildings (thermal, acoustic, lighting and quality of air), energy performance and the integration of innovative systems in buildings (mechanical, electrical and automation).
  - Datasheets on R&D and practice. Action reports on research, collaborative papers

- **WP7:** Analysis of functional materials and applications and new technologies – case-study
  - Case-study publication with recommendations and guidelines

---

**WG3 – Life-time structural engineering**
Design for durability, life-cycle performance, including maintenance and deconstruction

- **WP8:** Life-cycle performance: verification methods for durability of constructions (degradation models and service design life)
  - State-of-the-art report, datasheets of ongoing research

- **WP9:** Monitoring of life-cycle performance (life-cycle safety, functionality, quality, demolition and deconstruction)
  - State-of-the-art report, datasheets of ongoing research

- **WP10:** Sustainable construction assessment and classification systems
  - Case-study publication, including technologies, evaluation methods, recommendations, and basics for guidelines

---

**Case-studies**

**Buildings:**
- Light steel frame residential building
- Multifamily concrete building
- Seismic retrofitting technics
- Virtual office

**Bridges:**
- Three-span motorway viaduct
- Existing 30 years old bridge
- Integral abutment bridge
Deliverables

- Work Package Reports
- Reports and Datasheets from Case Studies
- Guidance on the use of the databases
- Proceedings of the First Workshop
- Proceedings of the Mid-term Seminar
- Proceedings of the Second Workshop
- Proceedings of the Conference
- Final Report
- A Summary Report, including recommendations for "Sustainability analysis of Structures"

Results vs. Objectives

Achievements:
- State-of-the-Art of LCA in sustainable construction finalized
- State-of-the-Art of Life-time Structural Engineering finalized
- State-of-the-Art of LCC, databases and educational material in progress
- Collaborative papers on recycled and emerging materials
- Collaborative works on energy-efficient construction
- Collaborative scientific papers on degradation models
- Guidelines for Case-studies (buildings and bridges)
- Emphasis on Students and ESR's (Competition, Training Schools)

Not yet achieved:
- The implementation of a global life cycle approach has not yet been fully achieved still - because of the holistic nature of sustainability.
  The picture is still far from complete (one of the most difficult issues worldwide) and cannot be achieved by a single research group/institution
Highlights - 1

Midterm Seminar - Dresden October 2008

- Keynote lecture on interdisciplinary methods in lifetime engineering
- Invited keynote speakers A. Tombazis, F. Mazzolani, E. Gürther, W. Winter, W. Sobek & B. Wellmer
- Milestone papers of Work Packages and Collaborative Works
- Workgroup meetings successfully planned future activities.

Highlights - 2

Naples Symposium + MC + WG’s – May 2009

- Number of participants ~ 80
- Number of represented COST countries ~ 27
- Introduction of COST and C25 to a large audience > 120
- Keynote Speakers Dan Frangopol (USA), M. Lavagna (Italy) and P. Hajek (Czech Rep.)
- Student Competition Awards
- Successful Working Group meetings
- Significant progress in Case-studies
Highlights - 3

Timisoara Workshop + MC + WG’s, October 2009

- Number of participants – 65
- Number of represented COST countries - 23
- Four jointly prepared Key note lectures:
  - Durability and service life of wood structures and components - State of the art
  - Condition assessment of steel structures - Recommendations for Estimation of Remaining Fatigue Life
  - A sustainability approach in structural restoration: Application of Life Cycle Analysis in a steel-based intervention project
  - Education for Sustainable Development
- Scientific achievements of Working Groups were presented

Highlights - 4

3 Books:
- 1st Workshop Publication – September 2007
- Midterm Seminar Publication – October 2008
- 2nd Workshop Publication – October 2009

1st Book - 45 papers, 338 pp
2nd Book - 55 papers, 436 pp
3rd Book - 38 papers, 300 pp
Challenges

- The matter of Life-time Engineering is complex. On LCC, so far, the results have stayed behind the results on LCA.
- Advanced methods of Life-time Engineering and the Global Methodology were presented in the last meeting – Izmir, 24-25 May 2010.
- Collaborative Works inside WGs will be finalized in the next meeting.
- It is foreseen that decisive progress can be achieved in the next meeting and will clearly be linked to the final outcome.

Sustainable Construction and the Integrated Life Cycle Approach

Heli Koukkari