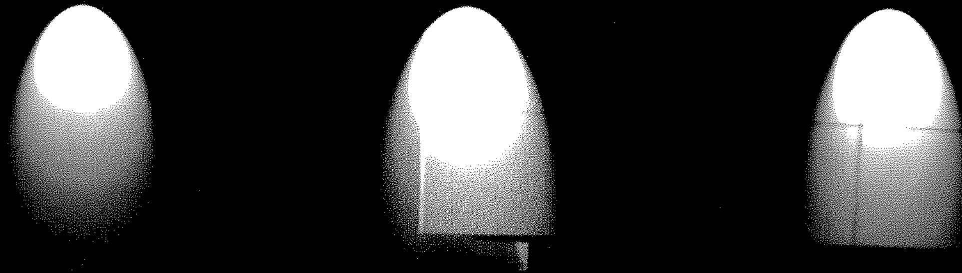

Sustainability of Constructions

Integr
Appro
Life
Str
En

Contents

Chapter 2. Eco-efficency

Chapter 3. Life-time structural engineering

Sustainability and Integrated Life-Cycle Design

Luís Bragança
University of Minho, Portugal

Heli Koukkari
VTT Technical Research Centre of Finland, Finland

Introduction

The building sector is one of the most important sectors for social and economic activities, being responsible to create, modify and improve the living environment of humanity. On the other hand, construction and buildings have considerable environmental impacts, consuming a significant proportion of limited resources of the planet including energy, raw materials, water and land. Therefore, the sustainability of the built environment, the construction industry and the related activities is a pressing issue facing all stakeholders.

The ecological rucksack of the construction sector is significant, and calls for rapid changes in technologies and processes. The strategic research activities and education of future professionals are of outmost importance for the progress. In this context, COST Action C25 is very timely, and its Memorandum of Understanding shows several topics of science- and research-based response to the global challenge. The Action covers subjects that represent both traditional engineering sciences and modern decision-making theories, but it "concentrates on methodologies that incorporate holistic understanding on the integrated processes and systems that result to the sustainability, quality and performance properties of buildings and built environment".

Life-cycle has become a new concept known by everybody but not applied so well as a principle to promote sustainability. According to the Standard ISO 14040, life-cycle assessment is defined as a compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle. The LCA is a methodology for analysing the environmental interactions of a technological system with the environment. It is in general considered part of "sustainability", although usually sustainability integrates social, economic and environmental objectives.

A variety of construction sector-specific methods and tools have been developed following the framework of the ISO standard. The long lifespan of buildings accentuates the whole lifecycle that includes effects of maintenance and demolishing, too. However, the LCA is most often carried out at the level of materials and components. Generic methods for the building level been developed, but they are still very much changing. The main goal of their developments, at the moment, is to create and implement a systematic methodology to achieve the most appropriate balance between the different sustainability dimensions, which is at the same time practical, transparent and flexible enough to be easily adapted to the different kind of buildings.

In two introductory papers, the state-of-the-art of the LCA methods in the construction sector is presented. In "Assessment of building sustainability", perspectives of the sustainability assessment of a whole building are presented based on feasibility study on performance analysis and development of extended LCA. The methods to combine functionality (performance) and data-based analyses are introduced. In the paper "LCA databases (EPD vs Generic data)", the concern is in suitability, reliability, availability and usability of LCA methods, tools and related databases.

The environmental life-cycle assessment is based on engineering data, but as such it is a systematic valuing process. Incorporation this new approach to everyday design and building practices needs more integration and communication. The rapid development of information and communication technologies is a basis for integration of modelling and simulation tools to LCA tools, and this evolution brings more opportunities to analyse building projects at different phases. Further, the achievements of the Building Information Modelling open new ways to use the LCA information.

The paper "An approach for an Integrated Design Process focussed on Sustainable Buildings" highlights the expectations and experiences about the LCA from the viewpoints of a world-wide design office. According to the authors, an interdisciplinary planning process is indispensable in order to develop and implement truly sustainable building concepts, and all designers involved in the project should participate at the earliest project phase possible. The paper proposes an approach towards sustainability as the governing factor in the compilation of all specifications and contract documents. The needs of guidelines to ensure a coherent and sustainable design process in all phases of a project are addressed.

It is generally accepted that improvement of sustainability starts with the following actions:

- maximise energy efficiency
- minimise waste in all phases
- maximise water efficiency
- optimise indoor air quality
- minimise embodied energy
- maximise the use of recycled, environmentally responsible materials.

The paper "Energy in the sustainable European construction sector" presents needs and methods to reduce the effects of one important flow in the LCA. The implementation of the Energy-Performance of Buildings Directive EPBD requires changes in design and building methods.

There are important issues related to the life-cycle concept that are a continuation of the engineering traditions in the construction sector: For the sake of safety, usability and comfort, the concepts of durability and serviceability are design criteria. The science- and research-based understanding of the phenomena that affect the duration of the life-cycle is the basis of service-life design methodology. The life-cycle – and phases of the life-cycle – is fundamental for assessments of environmental, economic, social or cultural impacts of components, buildings and other works.

For all kinds of works, durability is a major requirement that is included in all six essential requirements of the Construction Products Directive of the European Community (CPD). In the Guidance Paper related to the Directive, durability has been defined as "the property of lasting for a given or long time without breaking or getting weaker." Further, durability aspects are linked to the "working life" that means the "period of time during which the performance of the works will be maintained at a level compatible with the fulfillment of the essential requirements.

The widely used ISO Standard 15686 defines durability as the "capability of a building or its parts to perform its required function over a specified period of time under the influence of the agents anticipated in service". The factors that affect the duration of a life-cycle are the basis for development of service-life design methods.

The scope of the Action include, but is not restricted to, practical building technologies applications to promote sustainability, mathematical modelling, computer and experimental methods in the areas of sustainability assessment and evaluation, construction and design for durability, decision making, deterioration modelling and aging, failure analysis, field testing, financial planning, inspection and diagnostics, life-cycle analysis and prediction, loads, maintenance strategies, management systems, non-destructive testing, optimization of maintenance and management, specifications and codes, time-dependent performance, rehabilitation, repair, replacement, reliability and risk management, service life prediction, strengthening and whole life costing.

The papers prepared in the three Working Groups of the Action C25 give an overview of the research activities in relation to the wide field of the sustainable construction.