DYNASTEE
NEWSLETTER ISSUE 2016/6

A Network of Excellence...

Dynastee is offering, since many years now, information on the application of dynamic test, analysis and simulation methods tools for the evaluation of the energy performance of buildings. Through the course of international research projects, knowledge is gained on these advanced methods and tools have been developed. Many doctoral studies have been conducted at universities, of which several have been concluded successfully in the last year. These researchers have also taken profit from the trainings in the Dynastee Summer Schools, as well as from the exchange in international projects such as Annex 58. Presenting their own research work at project meetings was triggering others to go further and deeper in improving their methods. This resulted in greater knowledge of the complex phenomena of energy flows in building components.

This knowledge is now available for application on a larger scale. Several industrial companies have clearly understood the potential of this approach and joined the research community, in their search for practical applications.

Hence, Dynastee will continue to facilitate the knowledge transfer between this growing Network of Excellence and the potential users.

This newsletter gives you a glimpse of what is being achieved. More info, tools, papers and reports are available on www.dynastee.info.

Solar Decathlon 2013, Prague

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Newsletter Editors

- **Hans Bloem**
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Summer School 2015 in Denmark

For the 4th time DYNASTEE organised together with CIEMAT (Spain), ESRU (UK-Scotland), DTU (Denmark) and DYNASTEE under auspices of INIVE the Summer School on Dynamic Calculation Methods for Building Energy Assessment. Participants (25) from 11 countries joined the group to learn more about specific calculation techniques and software that could support them in assessing thermal characteristics of buildings using measured data from real experiments. Data, applications and software routines were made available for the participants.

Although mid summer, the temperature was not as many of us would have expected. However it did not influence the success of the Summer School.

Summer School 2016 in Granada, Spain

The success of the Summer School will continue in 2016 with a next Summer School in Spain, at the Civil Engineering School of the University of Granada from 19 – 25 June. Follow the information on the www.dynastee.info website.

Participants of the Summer School 2015 at DTU in Lyngby, Denmark

Coming to a closure of the IEA EBC Annex 58-project

'Reliable building energy performance characterization based on full scale dynamic measurements'

Staf Roels, Operating agent IEA EBC Annex 58

For four years, international experts from all over the world have been working together in the framework of IEA EBC Annex 58 on the topic of 'Reliable building energy performance characterization based on full scale dynamic measurements'. This project took place in the framework of the 'Energy in Buildings and Communities Programme' of the International Energy Agency. Since parts of the project build on previous PASLINK research, a close link was made with the Dynastee network and an update of the Annex 58 work was regularly provided in previous Dynastee-newsletters, as it is in this current one.

The last expert meeting in Prague (Spring 2015) officially closed the working phase of the project. Ever since, subtask leaders and participants have been working very hard to collect and describe all work done within Annex 58 in different reports, which are currently under review. Spring 2016 this outcome of Annex 58 will be presented to a broader audience. It contains:

- A report on the state of the art on full scale testing and dynamic data analysis, including a survey of existing full scale test facilities
- A decision tree to guide people in choosing the correct (full scale dynamic) test and method to characterize a certain performance
- A report describing the methodology to perform dynamic data analysis and performance characterization, and practical guidelines based on the lessons learned from the Common Exercises
- A few well-documented dynamic data sets (available as electronic data) which can be used for developing dynamic data analysis procedures and for validation purpose with corresponding document describing the outcome of the validation exercises of this Annex-projects
- A synthesis report, demonstrating the applications of the developed framework

And what after IEA EBC Annex 58?

Several research groups have indicated that they do not want to lose the momentum and good collaboration of the project. Furthermore, although a lot of progress has been made within IEA EBC Annex 58, several challenges remain. Annex 58 made a first step to characterize the actual energy performance of buildings based on full scale dynamic measurements. The focus, however, was mainly restricted to the thermal performance of the building envelope, making use of rather intrusive tests and focusing on scale models or test buildings. At the last IEA EBC ExCo-meeting a concept for a new research project has been presented. This project aims to make the step towards real in use buildings to pave the way for quality checks in daily building construction practice to guarantee that designed performances are obtained on site.

The main objectives of the new project are:

- Support the development of replicable methodologies to in situ assess energy performances of buildings in use
- Disaggregate the energy performance to the three main sources: building, systems and users

In Spring 2016 a workshop will be organized to fine-tune the project proposal, so the good work of Annex 58 can hopefully be continued in a new IEA EBC-project starting from September 2016 on.

Further information about IEA EBC Annex 58 can be found at: www.ecbcs.org/annexes/annex58.htm

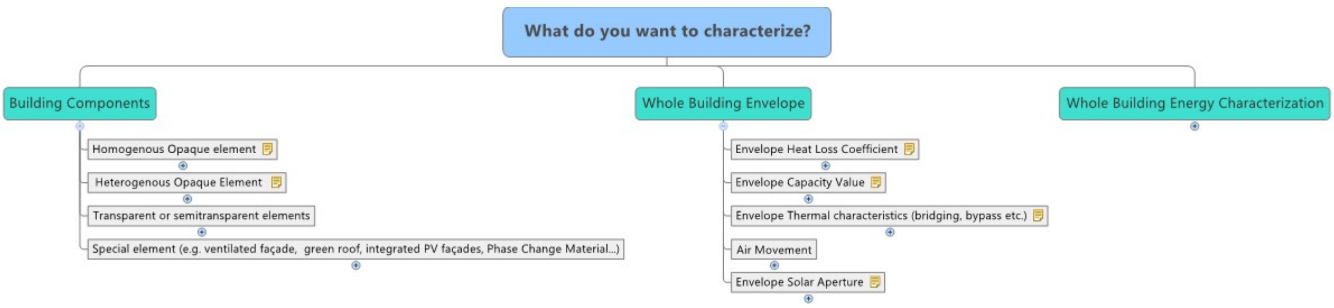
Subtask 2: Decision Tree

Martin Fletcher, Leeds

Annex 58 of the International Energy Agency's Energy in Buildings and Communities Programme is an international research collaboration on the topic of 'Reliable building energy performance characterization based on full scale dynamic measurements'. The goal of the Annex is to develop the necessary knowledge, tools and networks to achieve reliable in-situ dynamic testing and data analysis methods that can be used to characterize the actual energy performance of building components and whole buildings.

In Subtask 2, focus on 'Optimizing full scale dynamic testing', a procedure on how to realize a good test environment and test set-up was developed with expert contributions from the Annex 58 scientific committee. The aim was to arrive at a roadmap on the reliable methods used to measure the actual thermal performance of building components and whole buildings. The roadmap (using the decision tree logic) is aimed at multiple audiences from both academic and industry backgrounds.

Since there are many different objectives when measuring the thermal performance of buildings or building components, the method considered most appropriate to address the options was to map out a decision tree to guide the user through defined options. The decision tree's logic was informed by the scientific expert group of the annex, and is aimed at the users need to understand a building, component or element behavior. Where the user of the decision tree has a clear idea of the objective of the test to be carried out, the decision tree will provide information on test procedures and standards where information is available, and will provide a link or reference to the detail of the test.



Three main branches of the Decision Tree

Validation of common building energy simulation models based on in-situ dynamic data

Paul Strachan, ESRU

This Annex 58 subtask 4.1 involved empirical validation studies on full-scale buildings, aimed at determining the reliability of detailed building energy simulation programs to predict the energy and environmental performance. It involved a high proportion of the Annex 58 participants.

There is a marked lack of high quality datasets from real buildings (as opposed to test cells) suitable for validating dynamic thermal simulation programs, but fortunately the number of high quality test facilities is increasing, as identified in a detailed survey in Subtask 1 of the Annex 58 research. An appraisal of available test facilities for empirical validation was undertaken at the start of the Annex. The Twin Houses, a Fraunhofer IBP experimental facility at Holzkirchen, Germany, were selected. Two experiments were conducted: the first in summer 2013, the second in spring 2014. A comprehensive validation methodology was adopted. This comprised experimental design, developing a detailed specification, undertaking blind validation where modelling teams were only given boundary conditions and asked to predict internal conditions, results analysis, a second phase of modelling after all measured data were released, and re-analysis. Over 20 modelling teams were involved in following the experimental specification and submitting predictions using a range of commercial and research programs.

The pictures show the Twin Houses – preliminary testing showed they had similar air tightness and heat loss characteristics. These are relatively simple houses, but are of realistic dimensions. One important feature of the designed experiment was to use two essentially identical buildings in a side-by-side configuration with slightly different experimental set-ups, so that not only absolute comparisons of measured temperatures and heat fluxes could be made with the predictions but also measured and predicted differences between the two buildings could be compared. The houses were highly instrumented; detailed climate measurements were also made on-site. Each experiment comprised comprehensive experimental test sequences of almost 2 months duration in order to fully test the dynamic response of the buildings.

The main outcome from the study is the set of detailed specifications, augmented by feedback from modelling teams, and the detailed experimental datasets, all being made available through Open Access arrangements. Details of the first validation experiment and modelling results have been published as an Open Access paper in the Journal of Building Performance Simulation (DOI: 10.1080/19401493.2015.1064480).

External view of living room

Internal view of living room

CEN Standardisation and Annex 58

Hans Bloem, JRC

The EPBD defines the 'energy performance of a building' being the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting.

The main objectives of carrying out in situ measurements are:

- to assess the performance of a building or building component to justify renovation;
- to assess the performance improvement after carrying out energy efficiency measures;
- to verify real performance of a building or building component after construction against designed performances;

DYNASTEE and the IEA EBC Annex 58 project on the topic of 'Reliable building energy performance characterization based on full scale dynamic measurements' have been dealing with the particular issues of field measurements, analysis and quality. Field measurements and in situ test methods, in the context of building products, elements and structures, differ from laboratory test methods in terms of boundary conditions. Laboratory test methods are concerned with methodologies for the measurement of specific characteristics of buildings products (that define 'declared values' for the product performance, like the thermal resistance) and elements under well-defined and steady state conditions. In situ methods for testing are characterised by conditions of real climate and therefore variable conditions. The variability arises mainly from the effects of temperature, humidity, wind and solar radiation. In addition, in situ measurements deal with the application of building products in composed building elements or structures and therefore aspects that deal with thermal mass, heat and mass transfer. Discussions on a potential standard for in situ measurements of insulation products have been ongoing for several decades.

DYNASTEE has been for many years involved in many European research projects in the area of outdoor testing, analysis and modelling of buildings and building components.

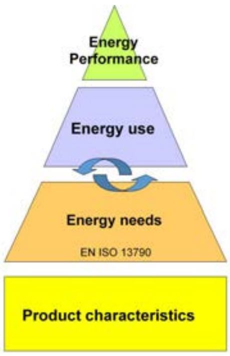
CEN decided in 2009 to establish a working group (CEN/TC89/WG13) with the objective of developing a standard assessment method based on in situ testing for buildings and building components. To date, no standard has been agreed and no standard is available that adequately deals with in situ test methods (measurements and evaluation) of construction products, building elements, or building structures. Consequently, research is urgently requested since traditional test methods do not adequately characterise the performance of buildings and certain building products as they are intended to be used.

ISO 9869 Thermal insulation - Building elements - In situ measurement of thermal resistance and thermal transmittance: limited in its application for one-directional heat flow and for homogenous slabs; Component characterisation.

EN ISO 6946 provides the method of calculation, based on a one-directional thermal flow, of the thermal transmittance of building components and building elements, excluding doors, windows and other glazed units, curtain walling, and components which involve heat transfer to the ground. The calculation method applies to components and elements made up of thermally homogeneous layers which can include air layers.

These standards refer to ISO 7345 (Thermal insulation - Physical quantities and definitions). This International Standard defines physical quantities used in the field of thermal insulation, and gives the corresponding symbols and units. This standard is restricted to thermal insulation.

The figure shows the relation between building energy performance and product characteristics.



Relation between building energy performance and product characteristics

Dynamic integrated method based on regression and averages, applied to estimate the thermal parameters of a room in an occupied office building in Madrid

Maria-Jose Jimenez, CIEMAT

A paper recently published (Energy and Buildings. Vol. 81, pages 337-362) reports the analysis of a room facing north in a fully monitored office building located in Madrid (Spain), carried out by CIEMAT. The starting point of this work is previous experience testing building components using test cells. Being conscious that the step forwards are not trivial, experiment set up intends to take advantage of similarities, and alternatives are proposed to take differences into account. The work reported in this paper is the first part of a bottom-up approach that is being applied for the analysis of a more remarkably complex system such as a room in occupancy conditions. Additionally, South European climate boundary conditions incorporate difficulties to data analysis, derived from experimental campaigns in the presence of high level of solar radiation and relatively low differences between indoor and outdoor air temperatures.

Data corresponding to a period of more than two years, recorded while the building was regularly used, have been employed. The availability of such a long data set gives strong support to validate results and to demonstrate the robustness of the applied methods and conclusions. A regression analysis method based on averages has been applied. Although the used equation is analogous to the steady state, dynamic features of the test have been considered. A dynamic energy balance equation is first stated. Then this equation is integrated for a time interval long enough to make the accumulation term much lower than the other terms. Finally averages are used to estimate integrals. The minimum integration period that allows this simplification has been identified, studying integration periods from 1 to 20 days.

The capability to extract some of the main thermal parameters for the considered room, from the available data set has been demonstrated. The main contributions to the energy balance in this room have been identified. It has been also studied the most efficient way to incorporate the most relevant effects regarding the analysis in the model. A spread in the Overall Heat Transmission Coefficient (UA) estimated under 10 %, was found for a 7-day integration period. This narrow interval allows to hand this parameter as intrinsic in practical applications.

The work reported in this paper is a very useful basis for future work that will apply differential dynamic approaches, which drastically reduce the required test period. The integrated approach reported in this paper gives very useful criteria to select and model the main contributions to the energy balance equation that will be used in upcoming works. Also, the obtained parameters provide a very useful support for validation in other analysis approaches.

External view of office building prototype at CIEMAT in Madrid, Spain

Interior room of office building prototype at CIEMAT in Madrid, Spain

ABOUT DYNASTEE

DYNASTEE is an informal grouping of organisations involved in research and application of tools and methodologies for DYNAmic Simulation, Testing and Analysis of Energy and Environmental performances of buildings. DYNASTEE provides a multidisciplinary environment for a cohesive approach to the research work related to the energy performance assessment of buildings in relation to the Energy Performance for Buildings Directive (EPBD). DYNASTEE, being a network of competence in the field of outdoor testing, dynamic analysis and simulation, has over 25 years of experience through a series of EU research projects. DYNASTEE is an open platform for sharing knowledge with industry, decision makers and researchers. DYNASTEE has the expertise needed to support the developments and design of Nearly-Zero Energy Buildings as required by the EPBD. Specific outdoor experimental work needs knowledge of the analysis process in order to optimise the dynamic information in the measurement data. Simulation requires results from analysis in order to be able to scale and replicate the results from analysis and testing to real buildings in different climates. DYNASTEE functions under the auspices of the INIVE EEIG. For more information visit the DYNASTEE web-site at www.dynastee.info