DYNASTEE
NEWSLETTER ISSUE 2014/4

Foreword

The main project of DYNASTEE at this moment is the IEA Annex 58 international collaboration on reliable building energy performance characterisation. This project is now on full speed and results are coming up at an increased tempo.

Young researchers are showing improved capabilities and skills in dynamic analysis methods. Training and common exercises push them towards new approaches and higher confidence in the results. This is a very promising trend and it shows the viability of the DYNASTEE exchange platform which is receiving more and more interest from industry and the wider research community.

This newsletter focusses on the progress in the work on dynamic analysis and simulation in the Annex 58 project, reports on a number of past information events and calls for a new training session. You are welcome to share your knowledge and take advantage of this growing source of competence. Join this community.

Above left: The Annex 58 group has become larger and larger, showing the increased interest in the topic of IEA ECB Annex 58 on "Reliable building energy performance characterisation based on full scale dynamic measurements"

Above right: Photo from new tall building under construction in Manhattan

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Newsletter Editors

- **Hans Bloem**
- **Luk Vandaele**

Seminar

REAL BUILDING ENERGY PERFORMANCE ASSESSMENT

Ghent, Belgium – Wednesday 16 April 2014

Around 125 participants attended this seminar that gave an overview of the current knowledge in the field of energy performance assessment. In general the energy performance of a building is essentially determined by:

• the thermal characteristics of the building envelope,

• the installed energy services to maintain the comfort level and

• how the building is used by its occupants.

As the latter is not easily predicted nor controlled, the first two are decisive in achieving the envisaged building energy performance as required by the EPBD, both for new buildings and renovations. The theoretical energy use calculated on the basis of building plans and specifications, in order to meet building regulations or specifications by the builder, determines the anticipated performance. It may differ, however, from the actual 'as-built' performance in a significant way which is recognised as 'the gap between performance calculation and measurement'.

The IEA EBC Annex 58 project on 'Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements' is working on understanding and bridging this gap between actual and calculated performance of the building. A consortium of researchers and industries from 15 countries are developing knowledge, tools and networks to achieve reliable in-situ dynamic testing and data analysis methods that can be used to characterise the actual thermal performance and energy efficiency of building components and whole buildings.

At this seminar an overview of the current knowledge in the field of energy performance assessment was presented by 9 invited experts. The seminar aimed also to look into the future of new building envelope applications and identifying answers how to close the gap between calculated and real performance. The proceedings of the seminar can be downloaded from the DYNASTEE web site.

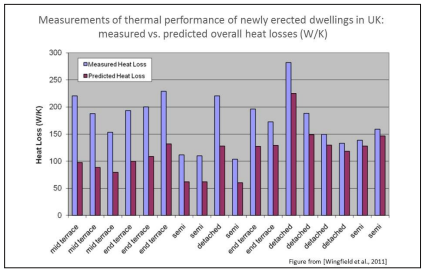
The practical organisation was in the hands of University Ghent and BBRI.

Webinar | 6 February 2014

How to determine the real performances of buildings? Building characterisation by co-heating

A common method to evaluate the thermal performance of a whole building in-situ is known as the co-heating test. This webinar tried to crystallise the current knowledge on the co-heating test, as applied for assessing the thermal characteristics of the building envelope. About 160 people participated to this internet based discussion. The presentations of the webinar can be downloaded from the DYNASTEE web site.

Both events were organised in the framework of the IEA EBC Annex 58 'Reliable building energy performance characterisation based on full scale dynamic measurements' through the DYNASTEE platform (www.dynastee.info) which is facilitated by INIVE (www.inive.org).



IEA EBC Annex 58, Subtasks 3 and 4

The research project IEA EBC Annex 58 on the topic of 'Reliable building energy performance characterization based on full scale dynamic measurements' takes place in the framework of the 'Energy in Buildings and Communities Programme' of the International Energy Agency. In the previous DYNASTEE Newsletter, no 3, we hightlighted Subtasks 1 and 2, respectively on the state of art on Outdoor Test Facilities and Optimization of Testing. In this issue of the newsletter, SubTask 3 on Data Analysis and SubTask 4 on Modelling will be introduced a bit more in detail.

Subtask 3: Dynamic data analysis and performance characterisation

This subtask focuses on quality procedures for full scale dynamic data analysis and on how to characterise building components and whole buildings starting from full scale dynamic data tests. Subtask 3 hence contains two major topics:

1. Development of procedures for high quality dynamic data analysis. Analysing the measured data of in-situ testing requires dynamic analysis methods and models. A wide range of methodologies exist, and it is often not easy to choose the most appropriate approach for each particular case. The activities are here centred on which methodology to use for dynamic data analysis, taking into account the purpose of the in-situ testing, the existence of prior physical knowledge, the available data and the statistical tools, etc.

2. Determination of reliable performance indicators for actual thermal performance of building components and whole buildings. Dealing with questions such as the validity of the usual approximations applied to obtain the static performance indicators when characterizing highly insulated nearly zero energy buildings and the need of dynamic performance indicators.

Common exercises and free papers are being used as instruments to move forward. The methodologies are being tested and validated on the data collected for the different case studies considered along the common exercises. Free papers are giving information on the current state of the art of the research activities in this area and facilitating discussions among participants along the different meetings.

A series of case studies are being considered for common exercises, starting from quite simple systems, progressively approaching to reality, to end with full size buildings. First, two exploratory exercises considering an opaque wall were carried out. Then another common exercise is based on the characterization of a round robin test box, which is seen as a scale model of a building, built by one of the participants, with fabric properties unknown to all other participants. Measurements have been performed on the test box in Belgium and Spain under real climatic conditions. Next common exercise is based on one of the Twin Houses at IBP Fraunhofer in Germany, also considered for validation exercises in Subtask 4. The experimental set up has been optimised to fit the objectives of the dynamical analysis. Analogous objectives to previous exercises have been set. However new challenges are incorporated when a full size building is considered. The dynamic data corresponding to each of these case studies are being distributed to all participants who are trying to characterise the thermal performance of the building fabric based on these measurement data. Apart from the characterization of the fabric also a cross validation and blind run was included in the exercises.

Participants have been asked to describe clearly, step by step the analysis and validation carried out. These exercises are demonstrating the application of different models and methods. These reports are important to facilitate identifying differences among the analysis approaches that could explain differences in results. This issue is being very useful to move forward in the research context of Annex 58. These first exercises have remarked the influence of experiment set up and test sequences and strategies on the accuracy of final results. These first exercises are also giving evidence of the relevance of skills in different areas of expertise and capabilities to combine all of them to obtain accurate results. Necessary skills are both regarding mathematical and statistical modelling and validation techniques, and regarding pre-processing criteria, physical knowledge and application of suitable approximations or assumptions. Multidisciplinary training in these combined and specific skills is being supplied by the DYNASTEE summer school on data analysis methods organised at DTU (2012, Denmark), CIEMAT (2013, Spain), and KU Leuven (2014, Belgium). More information: dynastee.info

Calls for free papers focussing on topics which are relevant regarding the overall objective of this subtask are being made for each expert meeting. Most presented contributions are related to thermal performance analysis of building "fabric". Many of these contributions report the study of different issues of modelling considering simplified situations either by simple cases studies, or by carrying out analysis based on simulated data. Relevant findings have been reported even from these simplified approaches.

Requisites on measurements and experimental set up, derived from requisites of data analysis is also considered in several reported works. In general it is concluded that the developed methodologies for dynamical analysis provide much more information about the characteristics of the building or the component than steady state methods, and moreover the results are provided using much shorter periods of experiments.

The multidisciplinary training has proven to provide a strong group of researchers which are able to carry out good experiments followed by appropriate use of methods from time series analysis to come up with reliable results. Besides this the methods for dynamic analysis have been further developed during the progress of the Annex work, and the latest version of the some of the developed tools can be downloaded from the DYNASTEE web page.

Some participants have already proven rather promising results regarding the analysis of full size buildings with a number of sensors and a number of rooms, even in the case of occupied buildings. One of the next steps will be to try to carry out an analysis for a skyscraper in Hong Kong.

Subtask 4: Modelling; Application of the Developed Framework

The objective of Subtask 4 is to apply the methods from other subtasks in order to demonstrate the importance of reliable full scale dynamic testing for assessing the energy and environmental performance of individual buildings and clusters of buildings as part of future smart grids.

Three distinct application areas are being investigated:

- Subtask 4.1: Validation of common building energy simulation programs based on in situ dynamic data
- Subtask 4.2: Characterisation of buildings based on in-situ testing and smart meter readings
- Subtask 4.3: Application of dynamic building characterisation for optimising smart grids

Regarding Subtask 4.1, although there have been many validation studies over the years, particularly within IEA Annexes and Tasks, they have mostly involved either comparative analyses or have been based on experimental data from test cells. There is a good reason for this – for validation of building energy simulation programs, a very high level of instrumentation and experimental control is required to ensure all important parameters are known. However, within the last few years, a number of high quality experimental facilities have been developed on more realistic buildings, as identified in Subtask 1. An evaluation was conducted of available facilities against a set of criteria considered necessary to ensure a good validation dataset. As a result, the Twin Houses in Holzkirchen, Germany (image below), developed and operated by Fraunhofer IBP, were identified as a good opportunity for providing a high quality validation dataset.

The twin houses are almost identical in terms of geometry, construction and air-tightness. A two month experimental schedule was defined consisting of a number of test sequences. For the majority of the experiment the external blinds on the south façade in one house were open; in the other they were closed. The experiment was carried out in August and September 2013. A detailed specification was circulated to IEA Annex 58 participants, together with detailed climate measurement and boundary conditions from the test site. Modelling teams were expected to submit their predictions of internal heat inputs and temperatures in a "blind" validation – i.e. without knowledge of the measured data. There was an excellent response - 21 datasets were submitted, from 13 organisations using 11 different commercial and research simulation programs. A preliminary graphical and statistical analysis showed that, as expected, there were some obvious cases of user modelling error. However, a number of model predictions showed good agreement with measured data which closely followed the experimental data.

The measured data has now been circulated to all teams and investigations are continuing into identifying modelling errors and model deficiencies. The datasets collected will be fully documented and available as validation datasets for future use by program developers.

In the remaining period of the IEA 58 programme, more attention will be paid to the other application areas. The rapid roll-out of home automation systems and smart meters will provide much information on energy consumption patterns within buildings. Subtask 4.2 will investigate if it is possible to apply the lessons learned from Subtasks 2 and 3 to characterise the dynamic thermal performance of buildings by using this information together with dynamic data analysis (e.g. by filtering out the user behaviour) without the need for significant additional on-site testing. Work is underway to define a common experiment that makes use of smart meter data to define suitable reduced-order dynamic models. This work will lead on Subtask 4.3 which makes use of these developed models to investigate how they can be used in smart energy grids to provide a more accurate characterisation of the dynamic behaviour of buildings and thereby improve the operation of smart energy grids.

DYNASTEE

Summer School 2014

1 – 5 September 2014, Leuven, Belgium

For the 3rd consecutive year DYNASTEE is organising with collaboration of universities, national research organisations and industry, a Summer School on the topic of **Dynamic Calculation Methods for Building Energy Assessment**.

Today, more and more data related to building and building components originate from outdoor testing under time-varying and dynamic conditions, or from real life use of buildings. The main purpose of this summer school is to train the students in a methodology for evaluation of measured data. Statistical modelling methods for using such time series data are discussed to assess valuable information about the energy performance of a building or the building element. An introduction to essential statistical techniques for model evaluation and selection are given with examples and through exercises. Many of the dynamic methods can be seen as techniques which bridge the gap between physical and statistical modelling. During the summer course, information on relevant software will be given and software tools will be used in the exercises. Specifically the focus will be on how to extract essential performance parameters of buildings using these models and techniques.

It will be shown how for instance the U-value of a simple homogenous wall can be estimated in dynamic conditions using different models and estimation techniques. It will also be shown that dynamic analysis methods linked to appropriate models can give rather detailed information about the various components of a building. The important aspects of applying models with a suitable complexity depending on the data are highlighted.

PhD students might be interested to know that 2.5 ECTS are awarded for attendance at this Summer School and a further 2.5 ECTS for additional work on a proposed exercise or centred on the students' own projects.

Download the Summer School 2014 Flyer from the DYNASTEE website and find further information, like the cost for participating, contents of the lectures, instructions how to register.

DYNASTEE Future Events

IEA EBC Annex 58 meeting in California at LBL, Berkeley from 18-19 September 2014. Prior to the meeting a workshop is organised on Wednesday 17 September with as title: "Real energy performance evaluation of buildings through measurement and simulation". More information can be found on the DYNASTEE website.

The Spring 2015 meeting of IEA EBC Annex 58 is planned to take place in Prague.

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**

The Summer School 2014 will take place at Heverlee - KU Leuven in Belgium