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IEA ECBCS Annex 58
Reliable building energy performance characterisation based on full scale dynamic measurements

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To reduce the energy use of buildings and communities, several countries imposed more stringent requirements. Mostly, requirements and labelling of the energy performances of buildings is done in the design phase by calculation or modelling. Several studies showed however that the actual performance after realisation may deviate significantly from this theoretically designed performance. Part of the deviations can be attributed to the user behaviour, but the main part has to be attributed to the physical features of the building and its systems. For the latter, building performance characterisation based on full scale testing – testing of building components or whole buildings under realistic dynamic conditions – could help to bridge the gap between theoretically predicted and real life performance of buildings. Full scale dynamic measurements are e.g. helpful to investigate the performances of building components and whole buildings as built in reality, including the influence of workmanship. This is illustrated in the figure below, which compares the designed and realised overall heat loss (W/K) of 18 dwellings in the UK. The overall heat losses are obtained with in situ co-heating tests . As can be seen none of the houses realises the intended performance and the measured heat losses of the houses may be up to 200% of the designed value.

Examples as those mentioned above, explain why at present several in situ testing activities are going on. A growing activity is observed in both full scale testing on building components (as e.g. in PASLINK cells or in situ on components of real buildings) and on whole buildings (to characterise thermal performance and energy efficiency of either test buildings or real buildings). So it is clear that, contrary to what was expected, the numerical building component and building energy simulation models did not make full scale testing of building (components) redundant. On the contrary, together with an increased application of numerical simulations, a renewed interest in full scale testing can be observed. This is not so strange, because dynamic full scale testing showed not only to be of interest to study building (component) performances under different real conditions – and as illustrated, quite often a huge difference is observed between predicted and realised performances –, it is also a valuable and necessary tool to integrate advanced components and systems into simulation models. So can dynamic data from full scale testing of advanced façade elements (double skin facades, facades with integrated photovoltaic cells,..) help to deduce grey box models . A grey box model is based on a combination of prior physical knowledge and statistics by identifying the unknown parameters of the system with dynamic data analysis. Once identified, the grey box model is able to predict the thermal dynamic response of the facade under different climatic conditions. This way it can be ensured that the behaviour of new advanced building components is integrated in a correct way in building energy simulation (BES) models.

A similar approach of parameter identification based on dynamic

Participants of the first preparation meeting, September 26-27, 2011, Leuven. In total 45 participants from 29 different institutes and 15 different countries were present.

measurements can be used to identify suitable models to describe the thermal dynamics of whole buildings including building systems. Characterising the dynamic behaviour of buildings is an essential and very valuable input e.g. when optimising energy grids for building communities.

But, notwithstanding the renewed interest in full scale testing, practice shows that the outcome of many on site activities can be questioned in terms of accuracy and reliability. The focus of nearly all full scale testing activities is on the assessment of the components and buildings, often neglecting the necessity of reliable assessment methods and quality assurance issues. Full scale testing however, requires quality on all topics of the process chain, starting with a **good test environment** (test cells or real buildings, accuracy of sensors and correct installation, data acquisition software,…). Only when this is present a **good experimental set-up** (e.g. test lay-out, imposed boundary conditions for testing,…) can be designed, which produces reliable data that can be used for **dynamic data analysis** based on advanced statistical methods in order to come to a characterisation with reliable accuracy intervals and final **use of the results**. As soon as the required quality fails on one of the topics, the results become inconclusive or might even be wrong. Therefore, the project aims an international collaboration in the context of IEA ECBCS to develop common quality procedures for full scale testing and data analysis to come to a reliable performance characterisation and prediction of building components and whole buildings. In the light of the importance of actual building performance characterisation, the current research proposal has two main objectives:

1. Develop common quality procedures for dynamic full scale testing to come to a better performance analysis

2. Develop methods to characterise and predict the actual thermal performances of building components and whole buildings based on dynamic measurement data.

The ultimate goal of the Annex is hence to *develop the necessary knowledge, tools and networks to achieve reliable in situ dynamic testing and data analysis methods that can be used to characterise the actual energy performance of building components and whole buildings.*

Expected outcomes

The deliverables from Annex 58 will be on the one hand a well-defined set of documenttation, as:

- 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
- Guidelines on how to perform reliable full scale dynamic testing, dynamic data analysis and performance characterisation, presented in the form of an extended report and summarised in a white paper
- A synthesis report, demonstrating the applications of the developed frame-work

On the other hand, Annex 58 will result in a network of excellence on full scale testing and dynamic data analysis. This network of excellence will organise on a regular basis events as international workshops, annual trainings,... and will be of help for organisations interested in full scale testing campaigns.

Meetings

- The 1st expert meeting was held in Leuven, Belgium in September 2011.
- The 2nd expert meeting was held in Bilbao, Spain in April 2012.
- The 3th expert meeting will be held in Leeds, UK in September 2012

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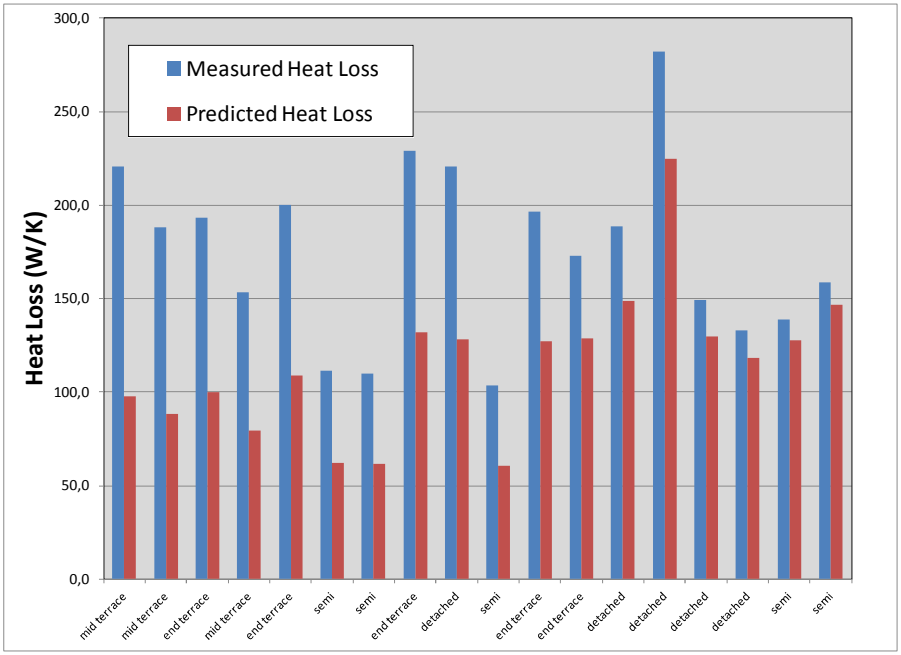
Participating Countries (provisional): Belgium, P.R.China, Czech Republic, Denmark, Finland, France, Germany, Italy, Japan, The Netherlands, Norway, Poland, Spain, United Kingdom, USA.

Further information can be found at http://www.kuleuven.be/bwf/projects/annex58/index.htm



Measured versus predicted whole house heat losses (W/K) for 18 new build dwellings in the UK. None of the houses is able to reach the designed values and deviations may go up to 100%. (Unpublished data from Leeds Metropolitan University, Leeds, UK).