



# Thermal conductivity

## Of Gypsum Plasterboards

### Subject

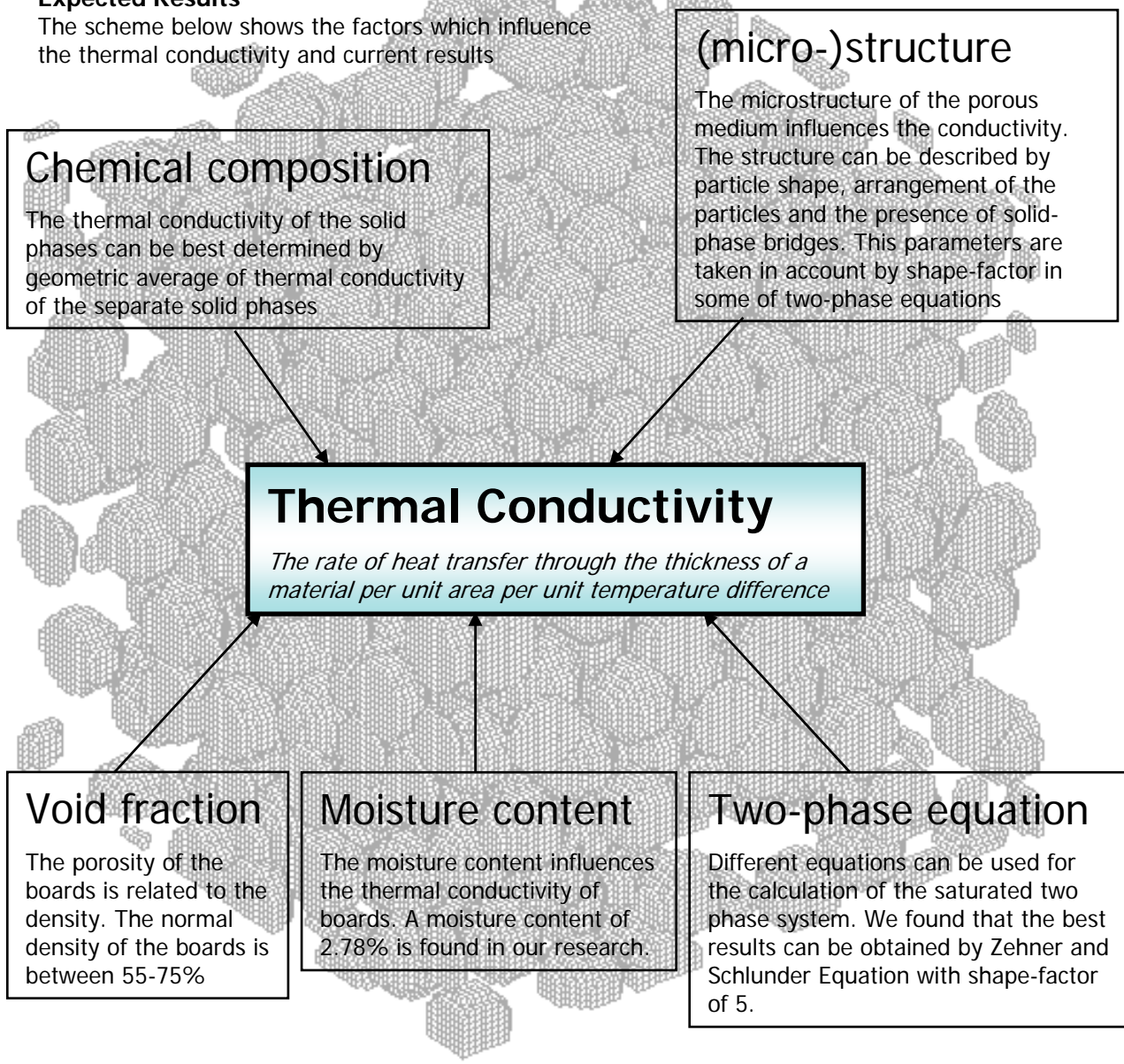
Thermal properties of gypsum plasterboards under fire

### Goal

One of the goal of this PhD-research is to predict the thermal properties of gypsum plasterboards with different composition in order to improve their fire behaviour. One of the more complicated thermal properties to calculate is the thermal conductivity. This parameter influences the fire behaviour.

### Expected Results

The scheme below shows the factors which influence the thermal conductivity and current results



### Chemical composition

The thermal conductivity of the solid phases can be best determined by geometric average of thermal conductivity of the separate solid phases

### (micro-)structure

The microstructure of the porous medium influences the conductivity. The structure can be described by particle shape, arrangement of the particles and the presence of solid-phase bridges. This parameters are taken in account by shape-factor in some of two-phase equations

### Thermal Conductivity

*The rate of heat transfer through the thickness of a material per unit area per unit temperature difference*

### Void fraction

The porosity of the boards is related to the density. The normal density of the boards is between 55-75%

### Moisture content

The moisture content influences the thermal conductivity of boards. A moisture content of 2.78% is found in our research.

### Two-phase equation

Different equations can be used for the calculation of the saturated two phase system. We found that the best results can be obtained by Zehner and Schlunder Equation with shape-factor of 5.



## Thermal conductivity Of gypsum plasterboards

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### Subject

Plasterboards often protect the steel structures of buildings, because its low thermal conductivity and its high volumetric enthalpy. Within this PhD-research the thermal properties of gypsum plasterboards under fire are studied. One of the more complicated thermal properties to estimated and calculated is the thermal conductivity of the boards. This property is described here in more detail. Thermal conductivity of the porous medium is influenced by several different (physical) factors; chemical composition, void fraction, (micro)-structure and moisture content. Besides that literature propose several equations to calculate the thermal conductivity of porous media.

### Goals

The goal of this part of the research is to predict the thermal conductivity of gypsum plasterboard based on this physical properties (density, chemical composition, (micro-)structure and moisture content) at both room temperature and during fire.

### Research Question

- Which theoretical equation describes the thermal conductivity in the best way?
- Which influence have the physical properties on the thermal conductivity and how could they be taken into account?
- Which changes in the thermal conductivity occur during fire?

### Strategy

The thermal conductivity of plasterboard can be assumed to be a three-phase system consisting of two saturated two-phase systems with air and water as fluid respectively. The first step is to calculate the thermal conductivity for this two saturated systems based on the equations from literature. The second step is to apply this concept to various types of board and compare the results with the experimental results available. The third step is to introduce the moisture content and drawn some conclusions with regard to the amount of absorbed water. The final step is to predict the thermal conductivity during fire based on the data about the changes in physical properties (density, composition, moisture content, ...).

### Results

The three-phase system can be best computed with the equation of Somerton, which uses the results of two-phase systems. Several equations are proposed to calculate the two-phase thermal conductivity. The best results, when comparing with experimental data from different gypsum plasterboards, were obtained in this research with the equation of Zehner and Schlunder with a particle-shape factor of 5. This particle shape factor describes the microstructure and particle shape which is characterized by needle-shape particles which have a high degree of interlocking. Within this research a moisture content of 2.8% is found to right value in order to explain the thermal conductivity to sufficient extent. The thermal conductivity of gypsum plasterboard during fire is influenced strongly by the changes in the physical properties.

### Preferred Partners Applications / Sponsors

The research is sponsored by the 6<sup>th</sup> FP-framework project "The Integrated Safe & Smart Built Concept" and usergroup cement-immobilisates-concrete at the University of Twente.

### Prime Publication / Prototyping

1. Korte, A.C.J. de and Brouwers, H.J.H. (2008). Production of non-constructive concrete blocks using contaminated soil. Submitted to Construction and Building Materials
2. Korte, A.C.J. de (2008). Hydration modelling of calcium sulphates. In R. Eligehausen and C. Gehlen (Eds.), 7th fib international PhD symposium in Civil Engineering. Stuttgart, Germany (vol. 8, pp. 3-13). Stuttgart, Germany: Universitat Stuttgart. Available from: 2008 Universitat Stuttgart, Germany
3. Korte, A.C.J. de and Brouwers, H.J.H. (2008). Contaminated soil concrete blocks. In M.C. Limbachiya and H.Y. Kew (Eds.), Excellence in concrete Construction through innovation, 9-10 September 2008, Kingston upon Thames, United Kingdom (pp. 107-118) London, UK: CRC Press Taylor & Francis group (ISBN 978-0-415-47592-1)

### Research Period

January 2007 - January 2011      Research School Integral Design of Structures