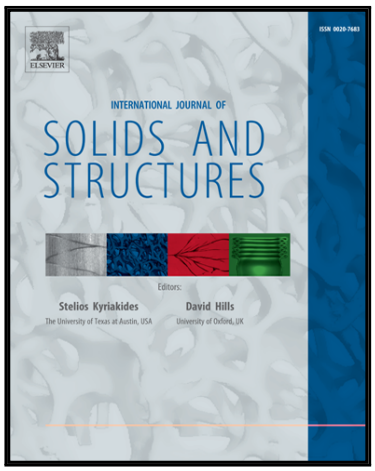

Modelling the microstructure and computing effective elastic properties of sand core materials

Matti Schneider, Tobias Hofmann, Heiko Andrä, Philipp Lechner, Florian Ettemeyer, Wolfram Volk, Holger Steeb

PII: S0020-7683(18)30055-6
DOI: 10.1016/j.ijsolstr.2018.02.008
Reference: SAS 9893

To appear in: *International Journal of Solids and Structures*

Received date: 8 December 2017
Revised date: 5 February 2018
Accepted date: 5 February 2018

Please cite this article as: Matti Schneider, Tobias Hofmann, Heiko Andrä, Philipp Lechner, Florian Ettemeyer, Wolfram Volk, Holger Steeb, Modelling the microstructure and computing effective elastic properties of sand core materials, *International Journal of Solids and Structures* (2018), doi: 10.1016/j.ijsolstr.2018.02.008

Modelling the microstructure and computing effective elastic properties of sand core materials

Matti Schneider[a,*], Tobias Hofmann[b], Heiko Andrä[b], Philipp Lechner[c], Florian Ettemeyer[d], Wolfram Volk[c,d], Holger Steeb[e]

Address

[a]*Karlsruhe Institute of Technology, Institute of Engineering Mechanics*
[b]*Fraunhofer Institute for Industrial Mathematics ITWM, Kaiserslautern, Department of Flow and Materials simulation*
[c]*Technical University of Munich, Institute of Metal Forming and Casting*
[d]*Fraunhofer Research Institution for Casting, Composite and Processing Technology IGCV, Garching, Department of Casting Technology*
[e]*University of Stuttgart, Institute of Applied Mechanics*

Abstract

In this article we model sand core materials on the micro-meter scale, resolving individual sand grains and binding bridges, to obtain effective elastic moduli of the composite by computational homogenization, laying the foundations for investigating the strength properties of core blown parts with foundry applications.
We analyze sand core materials on the basis of X-ray micro-computed tomography (μXRCT) images and extract a couple of sand grains from this volume image. These grains enter a packing algorithm which can generate granular packs with high packing fraction and incorporate sand grains with high complexity. Furnished with binder the resulting microstructures are investigated, deriving their effective elastic properties and studying the sensitivity w.r.t. the entering parameters. If a realistic range of elastic parameters of both sand grains and binder are plugged into the simulation, the agreement with experimentally obtained *P*-wave moduli is excellent.

Keywords: Composite materials, Elastic moduli, Homogenization, Micro-mechanics, Porous media

1. Introduction

Casting is a manufacturing process most often used for making complex shapes which would be either difficult or uneconomical to make by other methods [BS95]. Over 70% of all metal castings are produced with sand as the mold material [Rao03].
Sand cores consist of molding sand (with particular characteristics), binders, which serve to bond the sand particles together, and possible additives. The optimal mixture of these constituents is of vital importance. If the compound is not durable enough, it cannot withstand the casting process. On the other hand, it should be possible to extract the sand core after the casting without harming the metal part. Furthermore, the geometrical accuracy of the product

*Corresponding Author
Email address: matti.schneider@kit.edu (Matti Schneider)