Generating of Random Structures for Mathematical Modelling of Composite Materials

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Abstract

Real fibre composite materials often used in technology do not have periodic structure as is supposed in many mathematical methods. The contribution deals with generating random structures similar to real ones, four new algorithms are introduced.

1 Introduction

Composite materials are formed by at least two different phases(e.g. matrix and fibre). By various distribution of inclusions we can develop materials with special properties, that are intensively used in engineering. Our aim is to predict damage initiation, propagation of a discontinuity and consequently in final, failure of such material. Because of the experimental measurements, which is very expensive, we prefer to compute effective parameters from the knowledge of properties of phases and their distribution.

Solving of boundary-value problems modelling the behavior of composite materials is very demanding since we have to solve PDEs with highly oscillating coefficients and thus their numerical computation needs large systems of equations.

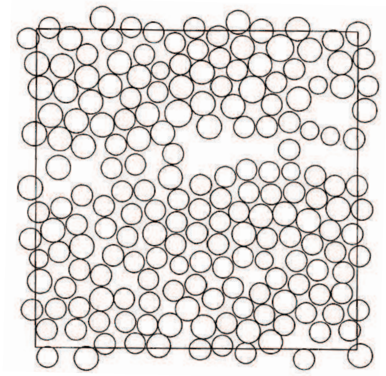

Figure 1: Real sample of a composite material taken from [1].

Real composite materials do not have periodic structure — distribution of the fibres in the matrix is not periodic, see [1]. The paper [3] studies question what error we do (in computations of boundary-value problem), if we replace random structure by an equivalent periodic one.

The base for modelling of non-periodic composite materials is generating of random structures, see the following picture. The aim of this contribution is to present four new algorithms (**AI**)–(**AIV**) for generating a random structure with the same volume fraction.

2 Simulation of Random Structure

An input argument for generating samples was the side of the square domain in μm, volume fraction and probability distribution of diameters of the fibres. According to [1], the following parameters were chosen: normal distribution N$(6, 78\mu$m;$0, 38\mu$m$^2)$, length of the sample's side 100μm and the volume fraction 0,55.

We have to note that in each of the previous algorithms the diameters of the fibres are driven by a known probability distribution. In our cases it was normal distribution described above. In the following pictures we can see the results of the mentioned algorithms (**AI**)–(**AIV**):

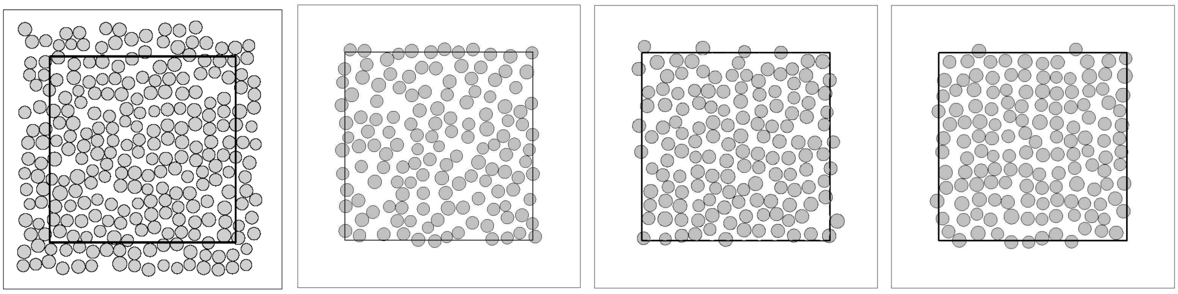

Figure 2: STRUCTURES GENERATED BY ALGORITHMS (**AI**) – (**AIV**).

3 Conclusions

The aim of this contribution was to show several algorithms for generating random structure of two-phased fiber composite material. Comparing these four algorithms, one can say, that the (**AIV**) is fastest, but the structure is not "so random". The following open problems are more sensitive comparison these algorithms based on statistical means, their likelihood to the real samples and efficiency of the simulation.

References

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