

Particle packing efficiency in concrete

Impact on elastic properties



RESEARCH SCHOOL
INTEGRAL DESIGN OF STRUCTURES

Speerpunt
BOUW

Subject

Concrete is a particulate material on different levels of the material structure, so particle packing phenomena are both significant on meso-level and micro-level. Particle packing are also expected to have an enormous effect on the mechanical properties of concrete.

Goal

Ultimate target of this research will be finding out the influences of particle shape and its packing on elastic properties of concrete and evaluation adequacy of the conventional numerical and analytical models based on spherical aggregate assumption.

Expected Results

Influence of shape of aggregate and packing results on elastic properties of concrete will be assessed. The impacts of other factors, such as mechanical and physical properties of aggregate, ITZ or matrix on elastic properties of concrete will also be addressed.

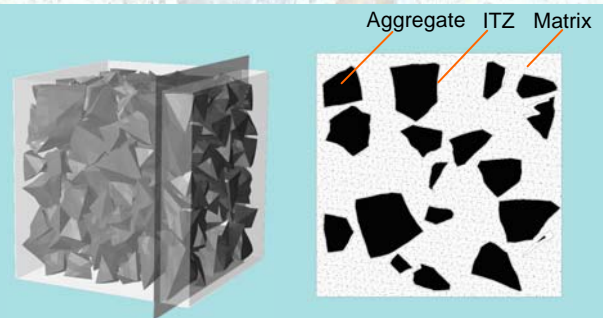


Concrete



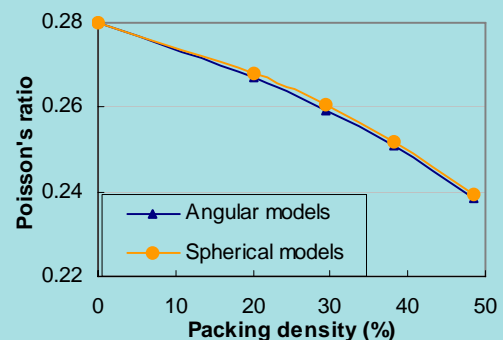
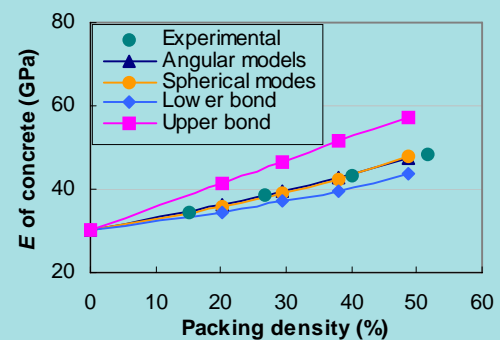
Cement paste

Particle packing in concrete and cement paste



Packing simulation by DEM and 3-phase modeling

A_A	Spherical	Angular
20.1%		
29.5%		
38.2%		
48.6%		



Elastic moduli and Poisson's ratios of models with different shapes and packing densities

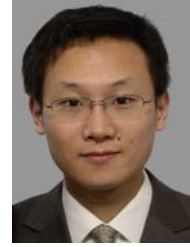
Particle packing efficiency in concrete Impact on elastic properties

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Subject

Concrete is a particulate material on different levels of the material structure, particle packing phenomenon is therefore significant on meso-level as well as on micro-level. Particle packing are also expected to have an enormous effect on the elastic properties of concrete.

Goals

Ultimate target of this research will be finding out the influence particle shape and packing on elastic properties of concrete and evaluation adequacy of the conventional numerical and analytical models based on spherical aggregate assumption.

Research Question

How do shape and particle packing affect elastic properties of concrete? Are conventional numerical and analytical models for elastic properties of concrete based on spherical aggregate assumption suitable?

Strategy

Using a concurrent algorithm-based discrete element simulation system, i.e. HADES, packed 3D structure with arbitrary shaped aggregate can be achieved. The comparison of numerical models with 3-phase structure will be performed aided by the finite element (FE) approach.

Expected Results

Influence of shape of aggregate and particle packing on elastic properties of concrete will be assessed. The impacts of other factors, such as mechanical and physical properties of aggregate, ITZ or matrix on elastic properties of concrete will also be addressed.

Preferred Partners Applications / Sponsors

Concrete material, material analysis equipments / construction consulting organizations

Prime Publication / Prototyping

- He, H., Guo, Z., Stroeven, P. and M.Stroeven (2008)

Discrete element approach to packing of arbitrary shaped particles in concrete, *Inżynieria Materiałowa* 2008: 4(164): 403-407.

- He, H., Stroeven, P., Guo, Z. and M.Stroeven (2008)

Comparison of experimental and SPACE simulation approaches to particle packing in concrete, In: Proceedings of the International Conference on Microstructure Related Durability of Cementitious Composites, Oct. 13-15, 2008, Nanjing, China, (RILEM publication S.A.R.L: 1169-1177)

- He, H., Guo, Z., Stroeven, P. Stroeven, M. and Sluys, L.J. (2007)

Self-healing capacity of concrete – computer simulation study of unhydrated cement structure, *Image Anal Stereol* 2007:26: 137-143.

Research Period

November 2005 – October 2009