BAC2010 – 2nd Iberian Congress on Self Compacting Concrete
University of Minho – Guimaraes, Portugal
July 1-2, 2010

Some Correlation Between High Packing Density, Ultra-High Performance, Flowing Ability, and Fiber Reinforcement of a Concrete Matrix

Antoine E. Naaman[1] and Kay Wille[2]
Department of Civil and Environmental Engineering
University of Michigan, Ann Arbor, Michigan, USA

The key intrinsic property of self-compacting concrete is its flowing ability defined as the ability of a mixture to fill a volume without vibration, segregation, separation, or bleeding. In order to achieve good flow ability, a number of parameters need to be optimized. The addition of fibers reduces the flow ability of a given mixture and introduces a number of additional parameters to be accounted for in the development of high-quality mixture.

In a first part this paper discusses the correlation between ultra high performance concrete and its flowing ability. To achieve ultra high performance, the packing density of the various particle components of the concrete is optimized. This is generally achieved by using particles of different mean grain sizes. In an ideal model the largest grain particles, assumed of same spherical size, are arranged in an ordered tetrahedral arrangement on superposing planes. While the theory suggests the size of smaller particles needed to increase the packing density, it is observed that a slight deviation from the theory is preferable in order to create an instability in the tetrahedral arrangement. This instability enhances the flowing ability. It is likely that particle size distributions with three to four properly selected mean sizes will lead to self consolidating ultra high performance cement composites with excellent flowing ability. Adding fibers to the mixture, increases the level of difficulty since fiber and grain particle sizes must be compatible in order to keep the true self flowing ability of the mixture without fiber segregation and with uniform fiber distribution.

In a second part the paper describes a project involving self-compacting ultra high performance fiber reinforced cementitious mixtures where particle packing was optimized at best. Compressive strengths up to 270 MPa are achieved. Mixture compositions and mixing procedure including mixing steps and mixing time for each step are described and the flow ability is shown to be of excellent quality.

---

1 Professor Emeritus, Dept. of Civil and Environmental Engineering University of Michigan, Ann Arbor, MI, 48109-2125, USA
2 Post-Doctoral Fellow, Dept. of Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI, 48109-2125, USA