Title Page

DEVELOPMENT AND APPLICATION OF HIGH STRENGTH CONCRETE WITH MULITI-FUNCTIONAL PROPERTIES

By

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Declaration

I hereby declare that the dissertation submitted does not contain the other research results has been published or written， except the references in the thesis. Comrades working together with me to our institute to do any contribution has been made clear in the paper indicate and expressed gratitude.

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Abstract

As a major load-bearing engineering material, high-strength concrete is the inevitable trend of development. However, it has higher viscosity, hydration heat, and self shrinkage, which makes it difficult to pump and cast concrete and makes concrete prone to cracks in the process of curing. Therefore, how to overcome these drawbacks in high-strength concrete is the key in the technical development and application of high-strength concrete. This paper studies systematically the powder effect of cement-based binding materials, key technology of reducing self-shrinkage, self-curing technology and the preparation of powder-effect-based low-heat high-strength concrete. These technologies are used to prepare one or several kinds of self-curing, low-shrinkage, low hydration heat, and self-compacting high performance high-strength concrete to be applied in practical engineering. The following main conclusions are drawn from the research and application: 1.When the content of ultrafine powder ranges from 0 to 40%, the mixing of ultrafine powder can help improve the powder compaction of compound cementitious materials; 2.In the ternary system of fly ash (D50=3μm), silicon ash, and cement, silicon ash can help further reduce the porosity of the compacted bulk; 3.Reducing the initial packing porosity of the powder system can enhance the fluidity of the newly mixed cement paste and the packing density of the hardened cement paste; 4.Reducing cement can reduce the temperature rise caused by hydration in the concrete, and reducing the fineness of fly ash can significantly improve every performance of the concrete; 5.Preparing high-strength concrete with low heat Portland cement can reduce the adiabatic temperature rise of the concrete by 6-10℃; 6.Using broken ice as a phase change material in high-strength large volume concrete can effectively reduce the concreting temperature of the concrete; 7.Using the imported water in the self-curing materials is an effective way to reduce self-desiccation in the hydration of cement and avoid great shrinkage and cracking of high-strength concrete in the early age; 8.In application, concrete can be “customized” in accordance with the requirements of the designer and the constructor and the features of various important or difficult projects.

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Chapter 1: Introduction

This chapter serves as an introduction to the study of high strength concrete which possesses special characteristics such as self-curing, self-compacting, low-hydration heat and so on. The definition and nature of HPC are initially given in brief. This is followed by a section explaining some of the practical engineering problems posed by HPC as encountered by engineers in the field. Although considerable efforts have been made over several decades to investigate and develop HPC, there seemed to be little work on the use of composite binder in HPC for high rise buildings. A section dealing specifically with this type of concrete is given in brief. Finally a section on the aims of the project is given at the end of the chapter, explaining briefly the aspects of HPC that are investigated in this thesis.

A more detailed review of previous work on the performance of HPC is given in Chapter 2 and the objectives and project methodology described in this thesis are fully explained in Chapter 3.

The concrete was developing to have low shrinkage ability, low hydration heat and high cracks resistance. The design and development of this type of concrete requires special consideration in many aspects from selection of raw materials, design criteria, material characterization, engineering properties of fresh and hardened concrete and finally the application in high rise building.

References

ACI Committee 363R. (1992). *Report on High -strength Concrete.* American Concrete Institute, Farmington Hills, MI(92) ACI.

ACI Committee 363. (1997). *State-of-the-art Report on High Strength Concrete. High Strength Concrete Seminar Course Manual*, SCM(92)ACI.

Adeline R., Laeheme M., & Blaif P. (1998). *Design and Behavior of the Sherbrooke footbridge*, *International Symposium on High Performance and Reactive Particle Concrete*. Sherbrooke : Canada.

Aim R.B., Goff P.L. (1967). Effect de Paroidans les Empilements Desordonnes de Spheres et Application a la Porosite de Mélanges Binaries. *Powder Technology*, 281-290.

Aitcin P.C. (1998). Autogenous Shknage Measuremeni. *Japan Concrete Instiute*, 245-256.

Aivaredo A.M., & Wittmann F. H. (1995).Shrinkage and Craking of Normal and High Performance Concrete. *HPC Materials Properties and Design,* 33-36.

An M.Z., Zhu J.Q., & Qin W.Z. Autogenous Shrinkage of High Performance Concrete. (2001). *Jouranl of Building Materials*, *4(2)*, 159-164.

An M.Z., Qin W.Z., & Zhu J.Q. (1998). Experimental Study on Autogenous Shrinkage of High-strength Concrete. *Journal of Shandong Institute of Building Materials*, 139-143.

An M.Z. (1999). *Study on the Autogenous Shrinkage of High Performance Concrete*. [PHD]. Tsinghua University, Bei Jing, China.

Barcelol B. & Rigaud, S. (1997). *Liner Volumetric Autogenous Shrinkage Measurement: Matuerial Behaviour or Experimental Artefact*. Proceedings of the Second International: *Research Seminar on Self-desiccation and Its Importance in Concrete Technology*. London : Great Britain.

Baroghel B.V., Godin J., & Gaw S.J. (1996). *Microstructure and Moisture Properties of High-Performance Concrete*. Proceedings from the 4th Inter-national Symposium: *Utilization of High-Strength/High-performance Concrete*. Paris: France.

Baroghel B.V., Altcin P.C. (2000). *International RILEM Workshop on Shrinkage of Concrete*—'Shrinkage 2000'. Paris: France.

Bentur A., Igarashi S., & Kovler K. (2001). Prevention of Autogenous Shrinkage in High Strength Concrete by Internal Curing Using Wet Lightweight Aggregates. *Cement and Concrete Research, 31*, 1587-1591.

Bentur A. (2001).*Terminologys and definitions*. Proceedings from the International RILEM Conference : *Early Age Cracking in Cementitious system*. Haifa: Israel.

Bentz D.P, Geike., & Hanser K.K. (2001). Shrinkage Reducing Admixtures and Early-Age Desiccation in Cement Pastes and Motors. *Cement and Concrete Research*, 7, 1075-1085.

Bentz D.P., Snyder K.A. (1999). Protected Paste Volume in Concrete Extension to Internal Curing Using Saturated Lightweight Fine Aggregate. *Cement and Concrete Research*, 29, 1863-1867.

Bissonnette B., Pierre P., & Pigeon M. (1999). Influence of Key Parameters on Drying Shrinkage of Cementitious Materials. *Cement and Concrete Research*, 1655-1662.

Bloom R., Bentur A. (1995). Free and Restrained Shrinkage of Normal and High Strength Concrete, *ACI Materials Journal*, 2, 211-217.

Brooks J.J., & Hynes J.P. (1993).Creep and Shrinkage of Ultra-High Strength Silica Fume Concrete. Proceeding from the 5th International Symposium: *Creep and Shrinkage of Concrete*. London: Great Britain.

Brooks J.J., Cabrera J.G. (1998). Factors Affecting the Autogenous Shrinkage of Silica Fume High Strength Concrete. *Japan Concrete Institute*, 185-192.

Building Construction Handbook. (2003). China: China building industry press.

Burkan O.I. (2004). Finite Element Modeling of Coupled Heat Transfer, Moisture Transport and Carbonation Processes in Concrete Structures. *Cement & Concrete Composites, (26)*, 57-73.

Cai Z.Y. (1982). *The performance of Concrete*. China: China building industry press.

Chao. X.M. (2012). *Study on Characteristics and Application of CaO Cementious Material Produced from White Sludge of Paper Mill*. WuHan University of Technology, WuHan, China.

Chen G.X., Ji G.J., & Lei A.Z. (2004). Study on Composition Effect of Multi-component Cementing Powder. *Journal of the Chinese Ceramic Society*, 32(3), 351-357.

Chen L.X, Feng N.Q. (2010). *New Materials of beads - Concrete Low-Carbon Technology*. 2010 Annual Meeting of Concrete Quality Committee and Technical Committee for Testing of Building Materials*: National New Concrete Technologies and Standards and Engineering Application.* Nanchang: China.

Chen Z.Y, Zhu J.C, & Wu P.G. (1992). *High Strength Concrete and Its Application*. China: China Building Industry Press.

Copelang L.E., & Bragg R.H. (1995). Self-desiccation in Portland Cement Paste. Portland Cement Association,12(3), 36-37.

Davis H.E. (1940). *Autogenous Volume Change of Concrete*. Proceeding from the 42th Annual: *American Society for Testing Materials*. Atlantic city: America.

Deng Y.S. (2008). *Utilization and Disposal of Coal Solid Wastes*. China: China Environmental Science Press.

Ding Q.J., Han J.Y., & Huang X.L. (2011). Research on Hydration Reactivity of Microsphere Compared with Silica Fume and Fly Ash. *Journal of Wuhan University of Technology,33(3)*, 64-68.

Ding Q.J., Han J.B., & Huang X. L. (2011). Comparative Study on Hydration Activity of Microbead and Silica Fume and Fly Ash. *Journal of Wuhan University of Technology, 33(3)*, 54-57.

Dong F.P. (2007). A Method to Fit Test Data of Adiabatic Rise of Temperature of Set Retarding Concrete. *Water Power, 33(3),* 47-48.

Dong R.Z., Ma B.G., & Xu Y.H. (2006). Double-critical Effect of Retarders on the Hydration and Hardening Process of Cement with High Cementing Property. *Concrete, (9)*, 3-6.

Fang W.Z. (2004). *Building Materials*. China: China Architecture & Building Press.

Feng N.Q. (1996). Structure, Performance and Powder Effect of High Performance Concrete. *Concrete and Cement Products, (2)*, 6-13

Feng N.Q. (1996). *High Performance Concrete.* China: China Architecture & Building Press.

Feng N.Q. (1998). Chinese High Performance Concrete Technology. *Journal of Shandong Institute of Building Materials, 12*, 1-5.

Feng N.Q. (2003). Development and Application of High Performance Concrete. *Construction Technology, 32(4)*, 1-6.

Feng N.Q. (2012). *Japanese Ultrahigh Strength Concrete and Green Concrete. The Third Cross-Strait-Four-Regions International Seminar on High-performance Concrete.* Wuhan: China.

Feng N.Q., Shi Y.X., & Hao T.Y. (2000). Influence of Ultrafine Powder on the Fluidity and Strength of Cement Paste. *Advance in Cement Research, 12(3)*, 89-95.

Feng N.Q. (1996). Technology of High Performance Concrete. Beijing: China.

Feng N.Q., Liu G.M., & Ba H.X. (2004) Effect of Grain Grading on Harmful Porosity of Cementing Materials. *Journal of Tongji University (Natural Science Edition), 3(9)*, 1168-1172.

Feng Q.G, Hirohito Y.C. (2003). Efficiency of Highly Active Rice Husk Ash on the High-strength Concrete. Proceedings of the 11th ICCC: *International Congress on the Chemistry of Cement*. Durban.

Feng S.H., & Li H. (2009). Study on Characteristics of Ultrafine Fly Ash and Hydration in Cement Paste. *Concrete, (3),* 38-40.

Gjorv O.E., Malhotra V.M. (1992). *High-strength concrete.* In Proceedings of the International Conference: *Advances in Concrete Technology*. Ottawa: Canada.

Glavind M., Pedersen E.J. (1999). Packing Calculations Applied for Concrete Mix Design, *Proceedings Creating with Concrete, 3(8)*, 35-39.

Goltermann P., Johansen V., & Palbol L. (1997). Packing of Aggregate: an Alternative Tool to Determine the Optimal Aggregate Mix. *ACI Materials Journal*, 94(5): 435-443

Guan X.M, Yang L, & Yao Y. (2004). Study on Durability of High Performance Concrete with a Low Water Cement Ratio. *Concrete, 10*, 3-5.

Hadjieva M. (2000). Composite Salt-hydrate Concrete System for Building Energy Storage. *Renewable Energy, 19(1)*, 111-115.

Hammer T.A. (2002). *Is there a Relationship between Pore Water Pressure and Autogenous Shrinkage before and during Setting*. Proceedings from the third International Ressearch Seminer: *Self-desiccation and its Importance in Concrete Technology*. London: Great Britain.

Hashida. H. & Yamazaki. N. (2002). *Deformation Composed of Autogenous Shrinkage and Thermal Expension due to Hydration of Highstrength Concrete and Stress in Reinforced structures*. Proceedings from the Third International Ressearch Seminar: *Self-Desiccation in Concrete*. London: Great Britain.

Hassane O., Hiroto T., & Yuji I. (2009). Use of High-strength Bars for the Seismic Performance of High-Strength Concrete Columns. *Journal of Advanced Concrete Technology*, *7*, 123-134.

Hawes D.W, Feldman D. (1992). Absorption of Phase Change Materials in Concrete. *Solar Energy Material Sand Solar Cells, 27(2)*, 91-101.

Hillermeier. B., & Sehroeder. M. (1994). Durability of High Performance Concrete. *Proceeding of international RILEM Workshop*.

Holland H.C. (1986). Use of Silica Fume Concrete to Repair Abrasion Erosion Damage in the Kinzua Dam Stilling Basin. *ACI Materials Journal*, 841-863.

Hua C., Acker P., & Ehrlacher A. (1995). Analyses and Model Autogenous Shrinkage of Hardening Cement Paste: L.Modeling at Macroscopic Scale. *Cement and Concrete Research,25(7)*, 1457-1468.

Huang G. X. (1999). *The Shrinkage of Concrete*. China: China building industry press.

Jensen O.M. (1995). Thermo Dynamic Limitation of Self-desecration. *Cement and Concrete Research*, *25(1)*, 157-164.

Jensen O. M., & Hansen P.F. (2001). Autogenous Deformation and RH-change in Perspective. *Cement and Concrete Research. 31(12)*, 1559-2565.

Jensen O. M., & Hansen P.F. (2001). Water-entrained Cement-based Materials. Principles and Theoretical Background. *Cement and Concrete Research. 31(5)*, 647-654.

Jian S.W. (2008). *Research on Preparation and Application of Inorganic Polymer-phase Change Shell Microcapsules*. Wuhan University of Technology, Wuhan, China.

Jiang Z.W. (2004). Self-desecration Effect of High Performance Concrete. *Journal of Wuhan University of Technology-Materials Science, (4)*, 55-58.

Jiang Z.W, Sun Z.P., & Wang P.M. (2003). Study on Autogenous Relative Humidity Change and Autogenous Shrinkage of Cement Pastes. *Journal of building materials，6(4)*, 345-349.

Jones M.R., Zheng L., & Newlands M.D. (2002). Comparison of Particle Packing Models for Proportioning Concrete Constituents for Minimum Voids Ratio. *Materials and Structures, 35(2)*, 301-309.

Johansen V., & Andersen P.J. (1991). Particle Packing and Concrete ProPerties. *Materials Science of Concrete*, 111-147.

Kmita A. (2000). A New Generation of Concrete in Civil Engineering. *Journal of Material Processing Technology, 106*, 80-86.

Kohno K., Okamoto T., & lsikawa Y. (1999). Effects of Artifidal Lightweight Aggregate on Autogenous Shrinkage of Concrete. *Cement and Concrete Research, 29*, 611-614.

Kolver. K. (1994). Testing System for Determining the Mechanical Behavior of Early Age Concrete under Restrained and Free Uniaxial Shrinkage. *Materials and Structure, 27*, 324-330.

Konerders A.B., & Breguel V.K. (1997). Numerical Modeling of Autogenous Shrinkage of Hardening Cement Paste. *Cement and Concrete Research, 27(10)*, 1489-1499.

Kong D.Y. (2000). Improvement and Application of Powder Packing Density Determination Method. *Laboratory Research and Exploration, (5)*, 46-49.

Konstantin K. (2005) Methods of Curing High-performance Concrete. *International conference on Civil and Environmental Engineering*, 8-17.

Lane G.A. (1986). *Solar Heat Storage: Iatent Heat Material*. Boea Raton: CRC Press.

Larrard D.F. (1992). A General Model for the Prediction of Voids Content in High-Performance Concrete Mix-Design. *Congres ACI/CANMET Advances in Concrete Technology*.

Larrard D.F. (1993). A Mix Performance Method for High Performance Concrete. *High Performance Concrete*, 48-62.

Larrard D.F. (1993). *A Survey of Recent Researches Performed in French 'LCPC' network on High Performance Concrete*. The Third International Symposium: *Utilization of High Strength Concrete*. Lillehammer: Norway.

Larrard D.F. (1990). Greep and Shrinkage of High Strength Field Concrete. *High Strength Concrete*, 577-598.

Larrard D.F., & Sedran T. (2002). Mixture-proportioning of High-performance Concrete. *Cement and Concrete Research, 32(10)*, 1699-1704.

Larrard D.F., & Sedran T. (1994). Optimization of Ultra-high-performance Concrete by the Use of a Packing Model. *Cement and Concrete Research*, *24(6),* 997-1009.

Leng F.G., Han Y.W. (2000). Development and Application of High Strength and High Performance Concrete and Discussion on High Performance Concrete. *Industrial Construction, 30*, 75-77.

Leung C.K, Cheung Y.N, Zhang J. (2007). Fatigue Enhancement of Concrete Beam with ECC Layer. *Cement and Concrete Research*, *37(5)*, 743-750.

Li B.C., Wang S.X., Wu C. (2001). Tensile Strain-hardening Behavior of Polyvinyl Alcohol Engineered Cementitious Composite (PVA-ECC). *ACI Materials Journal, 98(6),* 493-492.

Li B.X. (2008). Effect of Saturation Lightweight Aggregate and Self-curing on Shrinkage of High Performance Concrete. *Journal of Wuhan University of Technology*, 30.

Li L., Xue S.D., & Cao W.L. (2010). Seismic Performance Test of High Strength Concrete – Profile Steel Combined Shear Wall. *Journal of Beijing University of Technology,36*, 921-927.

Li P.P., Su D.G., Wang S.N. (2009). Influence of Mineral Admixtures on Hydration Heat of Paste and Chloride Diffusion Coefficient in Concrete. *Port Waterway Engineering, (11)*, 6-10.

Li S.Q. (2004). *The Research on Countermeasures to Prevent Cracking in Mass Concrete*. China: Tianjin University press.

Li S.J, Wu K.R. (2004). Zeolite Powder and Its Application to High Performance Concrete. *Shandong building materials, 25*, 40-43.

Liu B.J., Xie Y.J. (2003). Study on Influence Factors on Early Strength of Concrete with the Admixtures of Ultrafine Fly Ash Concrete. *Concrete, 1*, 13-15.

Liu B.J., Zhou S.Q. (2000). Performance of High Performance Concrete with the Admixtures of Composite Ultrafine Fly Ash. *Journal of building materials, 3*, 124-128.

Liu H.B. (1991). Particle Size and Packing Theory. *Journal of the Chinese Ceramic Society*, *29(2)*, 164-172.

Liu H.B. (1991). Particle Size and Packing Theory. *Journal of the Chinese Ceramic Society*, *29(2)*, 164-172

Liu L., Zhao S.Z. Study of the Influence of Mineral Admixtures on Concrete Adiabatic Temperature Rise. *The national special concrete technology and the engineering application of academic communication and concrete quality professional committee conference*. Beijing: China.

Liu S.H., Li X.J. (2006). The Effect of Minerl Admixture On Crack resistance Of High Strength Concrete. *New Building Materials, (12)*, 7-9.

Long G.C., Xie Y.J., Wang X.Y. (2002). Effect of Mineral Admixtures on Compaction of Fresh Cement Paste. *Journal of Building Materials, 5(1)*, 21-25.

Lura P. (2003). Autogenous Deformation and Internal Curing of Concrete. *DUP Science*, 63-65.

Lura P. (2003). Autogenous Deformation and Intrenal Curing of Concrete. [*PHD*]. Delft University of Technology, Holland.

Lyman C.G. (1934). Growth and Movement in Portland Cement Concrete. London: Oxford University Press.

Mazloom M., Ramezanianpour A.A., & Brooks J.J. (2004). Effect of Silica Fume on Mechanical Properties of High-strength Concrete. *Cement and Concrete Composites, 4*, 347-357.

Mak S.L, & Torii K. (1995). Strength Development of High Strength of Ultra High Strength Concrete Subjected to High Hydration Temperature. *Cement and Concrete Research, 25(8)*, 1791-1802.

Mao D. (2004). *Study on Grain Grading Effect of Mineral Particles in Cementing Composite Cementing Materials.* Master's Thesis. Hunan University, Changsha, China.

Marciniak S. (1999). *Autogenous deformations and relative humidity change: experimental studies* [PHD].Denmark: Department of Building Technology and Structural Engineering of Aalbory University.

Matsuda, T.N., & Takafumi. (2011). Mechanism of Early Heat Curing Influence on Compressive Strength and Autogenous Shrinkage of over 200mpa-class ultra-high-strength Concrete. *Journal of Structural and Construction Engineering, 76,* 1383-1392.

Matsui C., Keira K., & Kawano A. (1991). Development of Concrete Filled Steel Tubular Structure with Inner Ribs, *Proceeding of the Third International Conference on Steel-Concrete Composite Structure*, 210-216.

Mehta P.K. (1990). Principles Underlying Production of High-performance Concrete. *Cement concrete and Aggregate, 12(2),* 70-78.

Mehta P.K. (1999). Advancements in concrete technology. *Concrete International, 21(6),* 69-75.

Metha P.K. (1993). *Concrete Structure, Properties and Materials*. New Jersey: Prentice Hall press.

Mitui, Kenro, & Kojima. (2010). Development of 150-200N/mm^2 High Strength Concrete with Hybrid Fiber and Application to a Building Structure. *AIJ Journal of Technology and Design, 16*, 21-26.

Miyazawa S., & Tazawa E. (2001). Prediction Model for Shrinkage of Concrete Including Autogenous Shrinkage. *Creep, Shrinkage and Durability Mechanics of Concrete and other Quasi-Brittle Materials,* 735-740.

Nawy E. (1996). *Fundamentals of High Strength High Performance Concrete*. UK.

Nicholas J.C & James R.C. (1990). High Performance Concrete: Research Needs to Enhance Its Use. *Concrete International, 10(9),* 70-76.

Nie Q., Chen L., & Niu W.G. (2007). Effect of Different Admixtures on Cement Hydration Heat. *Coal Ash, (3)*, 1-6.

Niu Q.L., Feng N.Q., & Yang J. (2004). Analysis of Filling Effects of Ultrafine Mineral Substances in Cement Powder. *Journal of the Chinese Ceramic Society, 32(1),* 102-106.

Niu Q.L., Feng N.Q., & Yang J. (2002). Discuss on Mechanism of Action of Ultrafine Slag Powder. *Journal of Building Materials, 5(1),* 84-89.

Okamura H., & Ouchi M. (1999). *Self-compacting Concrete of Development, present and future*. 1st International RILEM Symposium on *Self-Compacting Concrete. Stockholm*, 3-14.

Okamura H., & Ozawa K. (1995). Mix Design for Self-compacting Concrete. *Concrete Library of JSCE,* 107-120.

Ozawa K., Maekawa K., & Okamura H. (1992). Development of High Performance Concrete. *Journal of the Faculty of Engineering, 3*, 149-157.

Paillere A.M., & Buil M. (1989). Effect of Fiber Addition on the Autogenous Shrinkage of Silica Fume Concrete. *ACI Material Journal, 86(2)*, 139-144.

Parviz, S., & Siavosh, R. (1998). Control of Plastic Shrinkage Cracking with Specialty Cellulose Fibers. *ACI Materials Journal, 4,* 429-435.

Pei M.S., Wang Z.F. (2008). The Properties of Cementitious Materials Super Plasticized with Two Super Plasticizers Based on Aminosulfonate Phenol Formaldehyde. *Construction and Building Materials, (22)*, 2382-2386.

Philleo R. (1991). Concrete Science and Reality, Materials Science of Concrete. *American Ceramic Society*, 1-8.

Pietro L., Felix D., & Ole M.J. (2006). *Autogenous Strain of Cement Pastes with Super absorbent Polymers.* International RILEM conference *on Volume Change of Hardening Concrete: Testing and Mitigation*. Denmark.

Prokopski G.J., & Halbiniak. (2000). Interfacial Transition Zone in Cementitious Materials. *Cement and Concrete Research, 30,* 579-583.

Rao G.A. (2001). Development of Strength with Age of Mortars Containing Silica Fume. *Cement and Concrete Research, 31*, 1141-1146.

Ribeiro A.B, Goncalves A., & Carrajola A. (2006). Effect of Shrinkage Reducing Admixtures on the Pore Structure Properties of Mortars. *Materials and Structures, 39,* 179-187.

Richard P., & Cheyrezy M. (1995). Composition of Reactive Powder concrete. *Cement and Concrete Research, 25(7),* 1501-1511.

Robert W. (2010). Design of the Smart Project, Kuala Lumpur, Malaysia. *Struct. Eng, 1*, 1-12.

Roy R.L., De L.F., & Pons G. (1996). *The After Code Type Model for Creep and Shrinkage of High-performance Concrete.* Proceedings of the 4th International Symposium on *Utilization of High-strength/High-performance Concrete*. Paris.

Roy R., & Larrardd F. (1993). *Creep and Shrinkage of High Performance Concrete.* Proceeding from the 5th International Symposium on *Creep and Shrinkage of Concrete.* London : Great Britain.

Salah A., Altoubat, & David A. (2001). Lange, Creep, Shrinkage and Cracking of Restrained Concrete at Early Age. *ACI Materials Journal*, 4, 323-331.

Schutter G.D. (2002). Finite Element Simulation of Thermal Cracking in Massive Hardening Concrete Elements Using Degree of Hydration Based Material Laws Computers and Structures. *Solar Energy Material sand Solar Cells, (80)*, 2035-2042.

Shanmugam N.E., & Lakshmi B. (2001). State of the Art Report on Steel-concrete Composite Columns. *Journal of Constructional Steel Research*, 57, 1041-1080.

Shen Y. (2002). Effect of the Silica Fume on the Early Shrinkage of Hardened Cement Paste. *Journal of Building Materials*, *5(4)*, 375-378.

Shen Y.Q. (2010). *Evaluation on Cement Compaction Structure and the Pore Structure and Performance of its Hardened Cement Paste.* Nanjing University of Technology, Nanjing, China.

Shi M.X., & Xie Y.J. (2002). Study on Hydration Performance of Cement- Fly Ash Composite Cementing Materials. *Journal of Building Materials, 5*, 114-119.

Shi X., & Cui H.Z. (2013). Phase Change Energy Storage Concrete Preparation and Its Mechanical Properties. *Concrete, (1),* 48-51.

Shinichi I., & Akio W. (2006). *Experimental Study on Prevention of Autogenous Deformation by Internal Curing*. International RILEM conference on *Volume Change of Hardening Concrete: Testing and Mitigation lynghy*.

Sommer H. (1998). *The Durability of HPC*. China.

Stovall T., Larrard F. D., & Buil M. (1986). Linear Packing Density Model of Grain Mixtures. *Powder Technology, 48(1),* 1-12.

Su A. (2008).*Study on Early-age Shrinkage Performance and Cracking Tendency of High Performance Concrete* [PHD]. Harbin Institute of Technology, Harbin, China.

Su N., Hsu K.C., & Chai H.W. (2001). Simple Mix Design Method for Self-compacting Concrete. *Taiw*an, 01, 1799-1807.

SuPPes G.J., Goff M.J., & LoPes S. (2003). Latent Heat Characteristics of Fatty Acid Derivatives Pursuant Phase Change Material Applications. *Applied Thermal Engineerin, (58),* 1751-1763.

Takeshi K., Tadahiko T., & Tsubota Y. (2001). Research on the Thermal Storage of PCM Wallboard. *Japanese Architecture Theory Accounting Art Collection, (540),* 23-29.

Tarun R., Naik R. K., & Bruce W. R. (2012). Development of High-strength, Economical Self-consolidating Concrete. *Construction and Building Materials, 30,* 463-469.

Tazawa E., Mststuoka Y. & Miyazawa S. (1994). *Effect of Autogenous Shrinkage on Self -stress in Hardening Concrete*. Proceedings from the International RILEM Symposium: *Thermal Cracking in Concrete at Early Ages*. Munich: Germany.

Tazawa E., & Miyazawa S. (1998). Experimental Study on Mechanism of Autogenous Shrinkage of Concrete. *Cement and Concrete Research, 28(8),* 1633-1638.

Tazawa E., & Miyazawa S. (1997). Influence of Constituent and Composition on Autogenous Shrinkage of Cementitious Materials. *Magazine of Concrete Research, 49(178),* 15-22.

Tazawa E. (1998). *Autogenous Shrinkage of Concrete.* America.

Tazawa E. (1999). *Autogenous Shrinkage of Concrete*. Britain.

Tazawa E., & Miyazawa S. (1995). Influence of Cement and Admixtrure on Autogenous Shrinkage of Cement Paste. *Cement and Concrete Research, 25(7),* 281-287.

Tazawa E. (1994). Autogenous Shrinkage of Cement Paste Caused by Hydration. *Cement and Concrete,* 35-41.

Tazawa E.I., Miyazawa S. (1995). Influence of Cement and Admixture on Autogenous Shrinkage of Cement Paste. *Cement and Concrete Research, 25(2),* 281-287.

Tian Q. (2005). *Shrinkage and the Mechanism of the Cement-based Material at Low Water to Binder Ratio Incorporating High Volume Mineral Admixtures.* [PHD]. Southeast University, Nan Jing, China.

Uzal B., & Turanli L. (2010). Pozzolanic Activity of Clinoptilolite: A comparative Study with Silicafume, Fly Ash and Non-zeolitic Natural Puzzling. *Cement and Concrete Research, 40*, 398-404.

Vaysburd A.M. (1996). Durability of Lightweight Concrete Bridges in Severe Environments, *Concrete International*, *18,* 33-38.

Wang A.Q., Zhang C.Z., & Zhang N.S. (1999). The Theoretic Analysis of the Influence of the Particle Size Distribution of Cement System on the Property of Cement. *Cement and Concrete Research, 29(11),* 1721-1726.

Wang A.Q., & Zhang C.Z. (1997). Study of the Influence of the Particle Size Distribution on the Properties of Cement. *Cement and Concrete Research, 27(5),* 685-69.

Wang A.Q., Zhang C.Z., & Tang M.S. (1995). Filling Effect of Pozzolanic Materials. *Concrete and Cement Products, 22(5),* 19-21.

Wang C., & Pu X.C. (2008). Test of Temperature Rise and Temperature Difference between Center and Surface of Super High Strength Mass Concrete. *Journal of Chongqing University*. *31(1),* 17-21.

Wang J.C., & Yan P.Y. (2006). Influence of the Dosage of Fly Ash on the Adiabatic Temperature Rise of Concrete. *Journal of Building Materials, 8(6),* 690-692.

Wang Q., Chen Z.C., & Yan P.Y. (2006). The Influence of W/B Ratio and Fly Ash Addition on the Autogenous Shrinkage of Concrete with Same Strength. *Concrete. (12),* 1-3.

Wang T.M. (1997). *Control on Engineering Structural Cracks.* Beijing, China: China Architecture & Building Press.

Wang Z, & Zhan N.T. (1996). *New Building Materials.* Harbin, China: Harbin Institute of Technology Press.

Weber S., & Reinhardt H.W. (1997). A New Generation of High Performance Concrete: Concrete with Autogenous Curing. *Adv Cem Based Mater, 6(2),* 59-65.

Wittlnann, E.H. (1968). Surface Tension Shrinkage and Strength of Hardened Cement Paste. *Constructions. 6,* 547-55.

Wu Y., Wang D.G., & Huang X.W. (2009). Pumping Performance Test of High Strength Concrete with the Admixtures of Slag and Fly Ash. *Journal of Liaoning Project Technology University (Natural Science Edition), 28,* 341-344.

Wu Z.W. (1999). *The High Performance Concrete*. China：China Railway Publishing House.

Xie Y.J. (2012). *The Study on High Performance Concrete with Ultrafine Fly Ash and Its Application*. Central South University, Changsha, China.

Xie Y.B. (2006). *Research and Application of Ultrafine Fly Ash High Performance Concrete.* Central South University, Changsha, China.

Xie Y.J., Zhou S.Q., & Yin J. (1998). Study on Effects of Actions of Ultrafine Fly Ash. *Journal of Shandong Institute of Building Materials, 12(51)*, 119-122.

Yan P.Y., & Cai Z. (2011). The Autogenous Shrinkage of Concretes Prepared with the Binders Containing Different Kinds of Minerl Admixture. *Industrial Construction, 41(6)*, 124-127.

Yang D.F. (1996). Study on Mixture Proportion of High Strength Concrete and Its Brittleness and Durability. *Concrete*, *2*, 23-30.

Yang W, Chen B.J., & Liu X.Q. (2013). Study on the Effect of Microbead on the Performance of Cementing Materials. *Concrete*.

Ye B.T., Jiang J.Y., & Sun W. (2011). Experimental Study on Reinforcing High Strength Concrete with Large Volume Mineral Admixtures Basalt Fibers. *Journal of Southeast University (Natural Science Edition), 41*, 611-615.

Yu A.B., Feng C.L., Zou R.P., & Yang R.Y. (2003). On the Relationship between Porosity and Interparticle Forces. *Powder Technology, 130(3)*, 70-76.

Yu A.B. (1987). Porosity Calculations of Multi-component Mixtures of Spherical Particles. *Powder Technol*, *52*, 233-240.

Yu L., & Guan M.Y. (2005). Durability and Anti-freeze-thaw Damage of Concrete. *Zhejiang Construction*, *22*, 54-55.

Yu Q.J., Zhao S.Y, & Feng Q.G. (2003). The Effect of Highly Reactive Rice Husk Ash on the Strength and Durability of Concrete. *Journal of Wuhan University of Technology, 25*, 15-19.

Zalba B., Marm J.M., Cabeza L.F., etal. (2003). Review on Thermal Energy Storage with Phase Change: Materials, Heat Analysis and Applications. *Applied Thermal Engineering*, *(23)*, 251~283.

Zang Z. (2001). Self-Compacting Concrete Methods for Testing and Design. *Boral Materials Technologies*, *2001*, 34.

Zeng J.J. (2010). *Preparation and Performance of Metakaolin Modified High Strength Concrete*. Unpublished Doctorial Dissertation, Wuhan University of Technology, Wuhan, China.

Zhang D.T. (1994). *The Cement Performance and Inspection*. China: China building industry press.

Zhang D. Zhou J.M., Wu K.R. (2003). Study on Fabrication Method and Energy-storing Behavior of Phase-changing Energy-storing Concrete. *Journal of Building Materials, 6(4)*, 374-379.

Zhang F. (2012). *Study on Dynamic Property and Damage of High Strength Concrete.* Unpublished Doctorial Dissertation, Guangzhou University, Guangzhou, China.

Zhang J., Qi K., & Hou D. W. (2009). Calculation of Temperature Fields in Early Age Concrete Based on Adiabatic Test. *Engineering Mechanics, 26(8),* 166-160.

Zhang J.L., Chen J., & Yang W. *A Method for Preparation of High Strength Self-Compacting Concrete*. China, 102887683A. [P].2013-01-23.

Zhang J., Stang H., & Li V.C. (2001). Crack Bridging Model for Biber Reinforced Concrete under Fatigue Tension. *International Journal of Fatigue*, *23*, 655-670.

Zhang S.Z., Wang S.C., & Qiao Y.J. (2010). Study on the Effect of Mineral Admixtures on Plastic Cracking of High Strength Concrete. *China Concrete and Cement Products, 5,* 24-27.

Zhang Z.M., & Garga V. K. (1996). Temperature and Temperature Induced Stresses for RCC Dams. *Dam Engineering*, *7(2)*, 129-154.

Zheng H.X. (2006) *Study on Hydration of Particle Adjusted Cement and Its Performance*. Harbin Institute of Technology, China.

Zhong S.Y. (2004). About the Durability of Concrete and Improvement Measures. *Journal of Wuxi Institute of Technology, 3,* 31-32.

Zhu B.F. (1999). *Mass Concrete Temperature Stress and Temperature Control*. China: China Electric Power Press.

Zhu B.F. (2003). Considering the Effects of Temperature of Concrete Adiabatic on Temperature rise of Expression. *Journal of Hydroelectric Engineering, (2)*, 69-73.

Zhu Q.J. (1999). *Development and Application of High Strength and High Performance Concrete.* China: China Building Materials Press.

ZhutovskyS. (2002). Modeling of Autogenous Shrinkage. Proceedings from the RILEM. Sendai: Japan.