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論　文　内　容　要　旨

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学位論文題目	Mechanical Properties and Durability Performance of Concrete Subjected to High Temperature Heating (高温加熱を受けたコンクリートの力学特性及び耐久性に関する研究)		

内容要旨

Concrete is the most widely used construction material in civil engineering due to its excellent mechanical and durability performance and the low cost since it was firstly developed in 19th century. As the progress of material science in the recent years, more and more new types of concrete such as self-compacting concrete, high-strength concrete, high-performance concrete, recycled concrete, light-weight concrete, porous concrete and fiber reinforced concrete, etc. were developed and applied in the actual engineering projects. In order to accelerate the application of the concrete in civil engineering, a lot of researchers conducted a series of experiments and simulations to investigate the properties of concrete such as the compressive strength, tensile strength, elastic modulus, stress-strain relationship, cracking, expansion, porosity, alkali-silica reaction, ion penetration resistance, steel corrosion and so on.

Since concrete is a kind of long-term used construction material which can be used as long as 50 years and more, the long-term properties of concrete such as the fire resistance and durability performance are need to be valued. Both the mechanical and durability performance of the concrete will be severely deteriorated due to the destruction of the concrete micro-structure when the concrete is subjected to a high temperature environment. After fire, the severely deteriorated concrete cannot be used anymore and will be replaced using the new concrete in the RC (reinforced concrete) structures. However, the concrete is still can be used after some strengthening and rehabilitation if the heating temperature is not too high. On the other hand, the residual durability properties of the fire damaged concrete will also be influenced by the high temperature even the deterioration of the mechanical properties is not serious.

Compared with the normal concrete, self-compacting concrete has a weaker fire resistance performance although it has been widely used in actual applications due to its improved rheological properties and durability enhancement since it was first developed in Japan in the late 1980s. Normally, the self-compacting concrete has a higher density compared with the normal concrete, which will generate the higher vapor pressure caused by the evaporation of the water in concrete when the concrete is subjected to the high temperature environment. This high vapor pressure can cause the explosive spalling of the concrete and severely destroy the micro-structure of the concrete.

According to the previous related researches, different kinds of additives such

as fibers and recycled aggregates mixed in the self-compacting concrete can improve its fluidity and fire resistance properties. However, the using of additives always deteriorates the mechanical and durability performance of the self-compacting concrete. In addition, the influences of different types of the additives on the mechanical and durability properties of concrete are also different. In order to accelerate the application of the different additives in self-compacting concrete, the related researches for the basic properties of self-compacting concrete containing different kinds of additives must be carried out.

On the other hand, copper slag (CUS) is a by-product generated during the process of copper smelting. Production of one ton of copper produces about three tons of copper slag and about 24.6 million tons of copper slag is generated from world copper production every year. The recycled copper slag can be used in concrete as a substitute for fine aggregate and improve the fluidity of the concrete, while the mixing of the copper slag fine aggregate also would promote the bleeding of the fresh concrete due to the high density and glassy smooth surface of the copper slag. In order to reduce the bleeding of the concrete containing copper slag fine aggregate, the application of copper slag fine aggregate to powder rich concrete like self-compacting concrete might be effective.

Although mixing copper slag aggregates into self-compacting concrete could both improve the fluidity of fresh concrete and reduce the bleeding caused by the copper slag fine aggregate, the residual mechanical and durability properties of high temperature damaged self-compacting concrete containing copper slag fine aggregate are still unknown and it has a great significance to carry out such related researches in order to investigate its properties and accelerate the application of copper slag as a substitute for fine aggregate in concrete.

In order to investigate the residual mechanical and durability properties of high temperature damaged concrete and offer data support for the strengthening and rehabilitation of fire damaged concrete constructions. Normal concrete with different water to cement ratios (W/C) and self-compacting concrete containing copper slag fine aggregate were prepared and conducted with high temperature experiment in this dissertation. The residual mechanical properties like compressive strength, splitting tensile strength, mass loss, porosity, elastic modulus, stress-strain curves and the residual durability properties like chloride ion penetration and steel bar corrosion of the high temperature damaged concrete were measured and comparatively analyzed. In addition, the micro-structure of the high temperature damaged concrete was also observed by using scanning electron microscope (SEM).