STANDARDS ON THE BLENDED CEMENTS

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Abstract

The cement industry is currently making various efforts to reduce CO_2 emissions. The blended cement produced by lowering the amount of clinker with using mineral additives has expanded as the trials to reduce CO_2 emission as well as to utilize its advantageous properties. And standards related to blended cement have been already set in all regions of the world. It is evaluated and reviewed the standards of blended cement according to the types and usage ratios of mineral additives that can be blended, which are covered by the European Standard (EN 197-1:2011), the Euro-Asian Standard (ГОСТ 31108-2020) and the U.S. Standard (ASTM C 595-16), respectively. In accordance with the blended cement standard established in each region, it is necessary to promote and expand the use of blended cement to reduce the CO_2 emission currently facing as well as to utilize various advantages of using blended cement.

Global warming and climate change due to the CO_2 emission are currently one of the most important issues in the world. In the cement manufacturing process, the CO_2 emission comes mainly from two parts: the raw materials and the fuel burning. Thus, nowadays, the cement industry is facing challenges to reduce CO_2 emissions. The production of cement is still responsible for about 5-8% of global total CO_2 emission. The main approaches to reduce CO_2 emissions in the production of Portland cement are: (i) increasing energy efficiency in the production process, (ii) use of alternative fuels to reduce fossil fuel combustion, (iii) replacing clinker by other mineral additive materials, and (iv) carbon capture and storage.

The incremental improvements in process efficiency have been adopted by the cement industry in recent years, and the use of alternative fuels to reduce the fossil fuel combustion in cement industry is now a standard in many countries, with some using a share of alternative fuels of more than 50% of the total amount of fuel required for the thermal processing. And one way of reducing CO_2 emission is the production of blended cements, which are formulated by blending of Portland clinker (or Portland cement) with other finely ground mineral additives or supplementary cementitious materials (SCMs) such as granulated blast furnace slag, fly ash, limestone powder, etc. The partial replacement of clinker, which is not only the more expensive component of cement, but also the most resource, energy and emission intensive, with mineral additives improve the sustainability of the material. Carbon capture and storage (CCS) is to limit the release of CO_2 emissions, which generated from to the calcination of raw materials and fuel combustion in the clinker production, into the atmosphere by capturing it and then storing it safely. Among the four methods that cement plants have successfully applied or are trying to reduce CO_2 emitted from the cement production, it will reviewed and evaluated on the standards in each region of the world to the blended cement which reduces CO_2 emissions as well as the amount of energy used in cement production, by lowering the clinker fraction with mixing of mineral additives' powder in cement.

Cement standards are indispensable for the application in the building/civil engineering industry. They provide obvious benefits in consumer protection with ensuring the quality and consistency of products and services. Many countries throughout the world have their own standards for cements, and furthermore, the use of blended cements is widely internationally accepted and standardized to reduce CO_2 emissions from the cement industry, by the defining the types and the blending fractions of mineral additives with clinker or cement. With the progressive introduction of SCMs – blast furnace slag, fly ashes or other pozzolans and, in due time, limestone fillers - the number of standardized cements has grown, including an increasing variety of composite cements due to new combination of SCMs. The SCMs' compositions in the blended cement are also more or less clearly defined in standards.

In the Europe, specifications of blended hydraulic cements are covered by the European Standard (EN 197-1:2011, Cement Part 1: Composition, specification and conformity criteria for common cements), in the Russia including central Asia by the Euro-Asian Standard (ГОСТ 31108-

2020, Cements for general construction), and in the U.S. by the American Society for Testing and Materials (ASTM C595-16, Standard specification for blended hydraulic cement), respectively. In addition to the above three regions of the world, standards related to each blended cement are established according to the types of mineral additives that can be utilized in each country such as China, India, Korea, Japan, Australia, and Canada, etc. Different standards and specifications across the countries specify different cements types based on different criteria.

EN 197-1:2011 defines and gives the specifications of 27 distinct common cement products and their constituents, in which cement includes the proportions of the constituents combined. According to the specified proportions of 6 types of main constituents such as blast furnace slag (S), silica fume (D), pozzolana consisting of natural (P) and natural calcined (Q) materials, fly ash representing siliceous (V) and calcareous (W) materials, burnt shale (T), and limestone classifying by the total carbon content not exceeding 0.50% (L) and 0.20% (LL) by mass. The Euro-Asian Standard (ГОСТ 31108-2020) suggests the 25 types of cement according to the blending of 8 types of constituents, such as blast-furnace slag (Ш), microsilica ($М_К$), pozzolan (П), gliezhi (Г), fly ash (З), burnt shale (С), belite sludge (Бш), and limestone (И), in which gliezhi (Г) is defined as thermally activated volcanic rocks and clays, burnt rocks, shales or sedimentary rocks, very similar to natural calcined material (Q) in EN 197-1:2011. The ASTM standard (ASTM C595-2016) specifies two major groups of blended cements as (a) binary blended cements which consist of Portland cement (PC) with either a slag, a pozzolan or a limestone and (b) ternary blended cements which consists of PC with either a combination of two different pozzolans, a slag and a pozzolan, a slag and a limestone or a pozzolan and a limestone, respectively.

By reviewing the blended cement standards of EN, ГОСТ and ASTM, countries around the world are establishing standards for the blended cement so that Portland cement (or clinker) can be mixed with various types of mineral additives. Through these standards, it is possible to make good use of the cementitious properties of mineral additives to be mixed, to preserve natural raw materials through the use of industrial by-products, and to reduce CO_2 emissions as well as energy consumption. Also, since it is already proved that the blended cement contributes to enhance the various properties including workability, high strength, durability, and chemical resistance of concrete, and it has advantages in terms of economy over Portland cement, it is necessary to expand the use of the blended cement. In particular, since the natural and artificial resources for locally available mineral additives that can be utilized in each country are different and limited, it is necessary to actively review and develop locally available SCMs in each country, and the application of blended cement have to be aggressively expanded for energy and CO_2 reduction by making good use of the advantages according to the standard of blended cement. In order to pass on a clean environment to future generations, the use of blended cement by selecting SCMs suitable for supply and demand conditions in each country to reduce CO_2, the main source of greenhouse gas nowadays has become essential and irresistible.

Conclusion

The standard for blended cement is an important item that can solve to some extent the current environmental problems such as global warming and energy problems. In Europe, Russia including central Asia, the United States, and other countries, in order to respond to environmental problems, standards related to blended cement have been established and revised, especially by subdividing cement based on low-carbon blended cement using industrial by-products and allowing the use of various mineral additives. In accordance with standards established in each region, it is necessary to add acceleration to the direction corresponding to the realization of carbon neutrality, by promoting and expanding the use of blended cement to reduce the CO_2 emission that countries around the world are currently facing as well as to utilize various advantages of using blended cement.

Uzbekistan's cement industry should also make efforts to expand the market so that it can actively utilize the advantages of the various physical properties of blended cement and the CO_2 reduction by using the already established standards.