

Cement

Hendrik G. van Oss, the cement commodity specialist for the U.S. Geological Survey, has compiled the following information on cement, an important material in construction.

Hydraulic cement is a virtually ubiquitous construction material that, when mixed with water, serves as the binder in concrete and most mortars. Only about 13 percent of concrete by weight is cement (the rest being water and aggregates), but the cement contributes all of the concrete's compressional strength. The term "hydraulic" refers to the cement's ability to set and harden underwater through the hydration of the cement's components.

The use of hydraulic cements dates back to ancient Roman times. Cements closer in composition to what is now commonly used were first discovered in England during the mid-18th century. In 1824, Joseph Aspdin, an English brickmaker, obtained a patent for an artificial hydraulic cement called portland cement, which was named after a dimension stone quarried on the Isle of Portland. The new cement proved to be superior to natural cements. In the United States, portland cement was not manufactured until 1871, in Coplay, Pa.

Because of many improvements in its manufacture, modern portland cement has only superficial similarity to portland cements of the 19th century. Portland cement may be mixed with other cement materials, such as fly ash and ground granulated blast furnace slag, to make blended cements, and with plasticizing agents, such as ground limestone and lime, to make masonry cements.

Limestone and, if needed for the chemistry, lesser amounts of clays and silica sand are the primary raw materials used to make portland cement. The mix of raw materials goes into a rotary kiln for pyroprocessing to form an intermediate product called clinker. The energy required to achieve the kiln reactions is enormous (typically, 3 million to 6 million British thermal units per metric ton of clinker). After cooling, gypsum is added to the clinker, and the mixture is very finely ground into portland cement. Gypsum prevents the cement (concrete) from setting too quickly.

World output of hydraulic cement has risen steadily in recent years. In 2004, world output was about 2.1 billion metric tons — enough to make about 2.5 tons of concrete per person on the planet. Of the approximately 150 producing countries, China's output was by far the largest, at about 934 million metric tons, followed by India, at about 125 million metric tons, and the United States, at about 99 million metric tons (from 115 plants in 37 states and Puerto Rico). U.S. cement consumption, primarily portland cement, in 2004 totaled about 122.5 million metric tons. The United States is dependent on imports to meet 20 to 25 percent of its consumption requirements.

The major environmental issue associated with cement manufacturing is the emission of carbon dioxide (nearly 1 ton of carbon dioxide is generated per ton of portland cement). After powerplants and motor vehicles, the cement industry and the iron and steel industry are more or less tied as the top two industrial emitters of this greenhouse gas.

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Samples of cement clinker. Image from *Minerals in Your World*.