Portland Cement: What Is It?

How It Is Manufactured from Clays and Limes

By Edward D. Boyer, Cement Expert

SO prodigious has been the growth of the Portland Cement industry, so marvelous its development, that the public in its breathless endeavor to keep track of ever-increasing uses of this wonderful material has scarce had the time to ask what the stuff itself is. And yet, despite the fact that Portland cement has become absolutely indispensable not only to the engineer and the builder, but on the farm and about the house as well, many a man, otherwise well informed, would be somewhat embarrassed for an answer, if asked point blank: "What is cement and where does it come from?"

So much has been said of Portland cement that one is apt to forget that there are other cements such as Rosendale, a slow setting cement, and Puzzolan, a product of iron slag. But the manufacture of these cements is insignificant compared with that of Portland cement. The brickmaker of Leeds who discovered that a wonderful product could be obtained by mixing the English chalk or lime with clays from the bed of the River Thames named the product Portland cement from its resemblance to a well-known and popular building stone in England, which stone was quarried on the island of Portland and was considered the hardest of the known building stones.

Portland cement was at first imported into the United States from Germany. Then the discovery was made that this country also contained materials from which the product could be manufactured. When, finally, we became interested in the product, with characteristic energy and enterprise we forced our way rapidly to the front, and with improved methods and appliances forged ahead until to-day American Portland cements are the acknowledged superiors of any in the world, not only in quality of product and improved methods, but in the quantity also.

In one region alone, the Lehigh Valley district, in the State of Pennsylvania, more Portland cement is manufactured than in the whole of Germany and England combined.

Within a decade (1899 to 1909) the cement industry of the United States has increased twelve hundred per cent! And this growth has been due to the fact that the American public has been quick to grasp the possibilities of this adaptable material. Here is an ideal building material, a stone that does not have to be hewn from solid rock, but merely mixed up like a paste with broken stone and sand and then poured in place! Could one ask for anything simpler or more opportune at a time

when the scarcity of lumber is becoming serious? No wonder the cement industries have grown.

Portland cement is a chemical composition, a trisilicate of lime and alumina. It can be manufactured wherever these materials can be found. In the Lehigh Valley, Pennsylvania, district, where for a long time 75 per cent of all the Portland cement in the United States was manufactured and where to-day about 50 per cent of it all is still manufactured, there are extensive natural deposits of what is known as cement rock, which, with the addition of a small percentage of lime, contains the ingredients before mentioned. This raw material is quarried and in various ways conveyed to the plants, where with a system of crushers and pulverizing machines it is crushed and reduced to a very fine powder. The process is continually controlled by chemical analysis, a corps of expert chemists being in charge of this work night and day. The resulting pulverized raw material of the proper chemical composition is then fed to rotary kilns, where it is burned to what is known as "cement clinker."

In the early days in Germany and England, as well as in the United States, Portland cement was burned in what were known as dome kilns, the mixture of limestone and shale in various shapes being set in these kilns with alternate layers of coal or coke, the product of a kiln seldom exceeding 100 barrels a day. In the year 1890 one of the largest Portland cement companies began experimenting with and rapidly developing what is now known as the "rotary kiln." This, to-day, is being used for calcining Portland cement in every mill in the United States and is gradually though surely succeeding the old dome kiln in Germany and England. These rotary kilns produce from 500 to 3,000 barrels of Portland cement per day according to their size and they alone have been largely instrumental in cheapening the cost of the manufacture to such an extent as to make Portland cement a cheap and economical building material.

Briefly described, a rotary kiln is a steel cylinder, six to twelve feet in diameter and from 60 to 250 feet in length, and is continuous in operation, the raw material being fed in at one end, and the finished product being discharged at the other end, toward which it travels by reason of the inclined position of the kiln and its rotary motion. During the passage of this raw material from one end of the kiln to the other, perfect calcination is obtained by the injection of pulverized

coal into the kiln by means of an air blast, the coal being ignited as it enters the kiln. The resultant clinker is then cooled and pulverized into a very fine powder and becomes the Portland cement of commerce. This process of grinding the raw material and later the clinker has been the serious problem of cement manufacture, as therein also lay an opportunity of lowering the cost of production. The reduction of any material to a fine powder by machinery involves great cost, and particularly was this the case with the materials entering into the manufacture of cement. It was early determined that the finer the raw materials were ground, the more intimate the mixture of the component parts; and while in the early stages of the industry, French burr stones were used for this purpose, to-day every mill is equipped with some form of heavy iron mill, which equipment not only increases the production per hour but also materially assists in reducing the cost.

Portland cement is seldom used neat or unmixed with sand and crushed stone or gravel. Mixed in this manner it forms what is known as concrete. This mixture of sand, stone and Portland cement with water becomes plastic when first mixed, and owing to this takes the form or shape of anything in which it is placed, whether wooden or iron forms, or sand or plaster molds, and within twenty-four hours becomes hard enough to have these forms removed, and within a week as hard as most of the natural stones. This material becomes harder as the years roll by, never deteriorates, never requires repairs, is waterproof, fireproof and in fact is everlasting. Its uses grow every year, from the early stages when it was only considered by the engineer for building foundations for building and machinery, until to-day it is the prime factor in every large building operation, and is familiar to both architect and engineer as a material that helps to solve problems hitherto considered incapable of solution. Think of just a few of the large engineering propositions of the day like the Panama Canal, the tunneling of the rivers, the subways, the large water storage and supply systems, the great irrigation projects of the West, and know that without Portland cement they would have been well nigh impossible. The variety of uses to which this wonderful material can be put can best be described in the statement that there is no engineering project too large nor any household use too small for the adaptability of concrete.

A battery of rotary kilns in a cement mill.

View of the driving gear. Note the relative size of the man.

MACHINERY OF A PORTLAND CEMENT FACTORY