

# CEMENT.<sup>a</sup>

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## INTRODUCTION.

To those who made large purchases of cement in 1904 the low prices which prevailed were doubtless satisfactory; but to the manufacturers of cement in the United States the year was not an encouraging one. Never in the history of the industry have prices been so extraordinarily depressed. In midsummer several of the mills in the Lehigh district were quoting selling prices which were below the cost of production and lower than any quotations ever before made by these mills. Later in the season there was a slight reaction, but the year closed with prices at a discouraging figure.

The cutting of selling prices in Portland cement naturally operated to lower the selling price and reduce the output of natural-rock cement, with the result that the production of the natural-rock cement mills for 1904 was very much smaller than that for 1903. These facts and the general uncertainty as to an immediate reaction in the cement market acted as a deterrent to a number of companies whose plans for building cement plants were already well developed, and many mills which were to have been built in 1904 were numbered instead among the projects which await a steadier market, better prices, and an increased number of orders for cement.

The building of the Panama Canal, which will require more than 12,000,000 barrels of cement; the rebuilding of the city of Baltimore, especially along the water front; the enormous increase in the consumption of cement caused by its use in the various forms of concrete construction, and the increasing demand throughout this country for cement sidewalks point toward a brighter outlook for the industry in the immediate future.

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<sup>a</sup> The entire statistical canvass and compilation of this report has been conducted by L. L. Kimball, of the United States Geological Survey.—D. T. D.

## ACKNOWLEDGEMENTS.

As the statements of statistics and the details of production set forth in this report are obtained directly from the owners and managers of cement plants in the United States, except in so far as they relate to foreign production and conditions, it will be readily understood that cordial and complete cooperation between the United States Geological Survey and the gentlemen in charge of the cement industry in this country is necessary to insure a comprehensive and approximately accurate report. Such cooperation has been almost invariably accorded, and for it the writer here expresses sincere thanks.

## TOTAL PRODUCTION.

The entire production of hydraulic cement in the United States in 1904 increased only 1,776,117 barrels over that for 1903, as a result of the continuation of the condition of the market outlined at the close of 1903 in the report made by this Bureau on the production of cement in 1903.

The total production of cement for 1904 was 31,675,257 barrels, valued at \$26,031,920, as against a total production in 1903 of 29,899,140 barrels, valued at \$31,931,341, which is a gain of a little less than 2,000,000 barrels in the quantity of cement produced, and a loss of nearly \$6,000,000 in value.

The production of Portland cement in 1904 was 26,505,881 barrels, valued at \$23,355,119.

The production of natural-rock cement in 1904 was 4,866,331 barrels, valued at \$2,450,150.

The production of Puzzolan or slag cement in 1904 was 303,045 barrels, valued at \$226,651.

## PORTLAND CEMENT.

## PRODUCTION.

Following is a table showing the quantity and value of the production of Portland cement in the States manufacturing this product in 1902, 1903, and 1904:



*Production of Portland cement in the United States in 1902, 1903, and 1904, by States.*

State.	1902. <sup>a</sup>			1903. <sup>a</sup>			1904. <sup>b</sup>		
	Num- ber of works.	Quantity.	Value.	Num- ber of works.	Quantity.	Value.	Num- ber of works.	Quantity.	Value.
		Barrels.			Barrels.			Barrels.	
Alabama .....	1	.....	.....	1	.....	.....	1	.....	.....
Arkansas .....	1	.....	.....	1	.....	.....	1	.....	.....
California .....	2	294,156	\$431,910	3	631,151	\$1,019,352	3	1,014,558	\$1,446,909
Colorado .....	2	82,044	105,016	1	258,773	436,535	1	490,294	638,167
Georgia .....	1	.....	.....	2	.....	.....	2	.....	.....
Illinois .....	4	767,781	977,541	5	1,257,600	1,914,500	5	1,326,794	1,449,114
Indiana .....	3	536,706	628,244	3	1,077,137	1,347,797	4	1,350,714	1,232,071
Kansas .....	1	830,050	1,017,824	1	1,019,682	1,285,310	2	2,643,939	2,134,612
Kentucky .....	.....	.....	.....	.....	.....	.....	1	.....	.....
Michigan .....	10	1,577,006	2,134,396	13	1,955,183	2,674,780	16	2,247,160	2,365,656
Missouri .....	1	.....	.....	2	825,257	1,164,834	2	.....	.....
New Jersey .....	2	2,152,158	2,563,355	3	2,693,381	2,944,604	3	2,799,419	2,099,564
New York .....	10	1,156,807	1,521,553	12	1,602,946	2,031,310	12	1,362,514	1,257,561
Ohio .....	7	563,113	685,571	8	729,519	998,300	7	910,297	987,899
Pennsylvania .....	15	8,770,454	10,130,432	17	9,754,313	11,205,892	17	11,406,099	8,969,206
South Dakota .....	1	.....	.....	1	.....	.....	1	.....	.....
Texas .....	2	165,500	234,950	2	.....	.....	2	.....	.....
Utah .....	1	.....	.....	1	.....	.....	1	.....	.....
Virginia .....	1	334,869	433,286	1	538,131	690,105	1	864,093	774,360
West Virginia .....	.....	.....	.....	1	.....	.....	1	.....	.....
Total .....	65	17,230,644	20,864,078	78	22,342,973	27,713,319	83	26,505,881	23,355,119

<sup>a</sup> The States combined for 1902 and 1903 are mentioned in the text of the reports for those years.<sup>b</sup> The States combined for 1904 are given in the text below.

As heretofore, States having but one producing cement plant have the figures showing their output combined with the figures for some other States to avoid exposing individual productions, which are not published except in combinations to make State totals, unless for some especial reason and with the full permission of the persons concerned.

In the table above the State combinations are as follows: Alabama, Georgia, West Virginia, and Virginia are reported together; the products of Kansas and Missouri are given in combination; and Colorado, Utah, and Texas have their products combined. In each case the combined product is given in connection with the State which was the largest producer.

For the year 1904, one new State is added in the table showing where the Portland cement plants of the United States are located, for the reason that although Kentucky did not produce Portland cement in 1904, the plant for that purpose was practically completed in that year. No new plants were started up in States not already recorded as producers of Portland cement.

The States stand in the same order of rank for 1904 that they held in 1903, so far as the leading producers of Portland cement are concerned. Pennsylvania, the heart of this branch of the cement industry, still holds first place, with a product which is more than 40 per cent of the

total quantity of cement manufactured in 1904. She increased her lead over that of the previous year by 1,741,786 barrels, and stands 8,696,680 barrels ahead of New Jersey, which ranks second, with a production amounting to 10.56 per cent of the whole. Michigan is still in the third place, her production being a trifle less than  $8\frac{1}{2}$  per cent of the total quantity of cement manufactured. New York was the fourth producer of Portland cement in 1904, having made about 5 per cent of the entire production.

When the pioneer cement plants turned out a few thousand barrels as a good year's work, the lead of a million or two barrels in a State would have meant much more than it did in 1904, when a number of plants—notwithstanding 1904 was a bad year—ran up into the millions of barrels for their individual production.

The States included in all other sections in the following table are Alabama, California, Colorado, Georgia, Illinois, Indiana, Kansas, Missouri, Texas, Utah, Virginia, and West Virginia, together with such counties in Pennsylvania as are not included with Lehigh and Northampton counties.

As in the similar table for 1903, Warren County, N. J., is not included with the Pennsylvania counties, but is included in the separate statement of the output of New Jersey.

Following is a table showing the growth of the Portland cement industry in the United States since 1890:

*Development of the Portland-cement industry in the United States since 1890.*

Section.	1890.			1900.			1902.		
	Num- ber of works.	Quantity.	Per cent.	Num- ber of works.	Quantity.	Per cent.	Num- ber of works.	Quantity.	Per cent.
		<i>Barrels.</i>			<i>Barrels.</i>			<i>Barrels.</i>	
New York .....	4	65,000	19.4	8	465,832	5.5	10	1,156,807	6.7
Lehigh and Northamp- ton counties, Pa., and Warren County, N. J. .	5	201,000	59.9	15	6,153,629	72.6	17	10,829,922	62.9
Ohio .....	2	22,000	6.5	6	534,215	6.3	7	563,113	3.3
Michigan .....				6	664,750	7.8	10	1,577,006	9.1
All other sections .....	5	47,500	14.2	15	663,594	7.8	21	3,103,796	18.0
Total .....	16	335,500	100.0	50	8,482,020	100.0	65	17,230,644	100.0

  

Section.	1903.			1904.		
	Num- ber of works.	Quantity.	Per cent.	Num- ber of works.	Quantity.	Per cent.
		<i>Barrels.</i>			<i>Barrels.</i>	
New York .....	12	1,602,946	7.2	12	1,362,514	5.1
Lehigh and Northampton counties, Pa. ....	13	9,631,541	43.1	15	11,411,620	43.1
New Jersey .....	3	2,693,381	12.1	3	2,799,419	10.6
Ohio .....	8	729,519	3.3	7	910,297	3.4
Michigan .....	13	1,955,183	8.7	16	2,247,160	8.5
All other sections .....	29	5,730,403	25.6	30	7,774,871	29.3
Total .....	78	22,342,973	100.0	83	26,505,881	100



## THE PORTLAND CEMENT INDUSTRY, BY STATES.

The production of Portland cement in the United States in 1904 was confined to 17 States, two other States, with but a single plant each, being nonproductive. In detail, the State production was as follows:

*Alabama.*—This State has but one plant manufacturing Portland cement, and that plant ran slightly behind its production for the previous year. The mills were closed down for several months, during which time alterations and improvements were completed. The only other plants in the State are manufacturers of slag cement, though there is a project for another Portland-cement plant which will be located at Selma, where well-known deposits of limestone suitable for use in the production of Portland cement occur abundantly. As yet, however, the mill has not been built. The other cement factories in Alabama were both active in 1904.

*Arkansas.*—The only plant in the State of Arkansas which has ever produced cement was idle throughout the year 1904. This mill has abundant material for the economical production of cement, and is built in a locality where no immediate neighbors exist to create competition. The low price of cement during the year and lack of funds with which to operate were the causes responsible for the idleness of the mill.

*California.*—There has been a steady and very marked increase in the output of cement from California within the last few years. In 1902 the returns showed but little more than a quarter of a million barrels of Portland cement produced in the State. In 1903 this amount was increased to more than a half million barrels, and in 1904 the total production for the State ran up to more than a million barrels. This quantity of Portland cement is the output of the three plants located in California. Of these three mills, one was idle nearly six months undergoing repairs and remodeling, one was closed for a short time that it might be overhauled, and the other ran practically on full time for the year. The increasing market for American cements in the Pacific States has had a marked effect on the imports of cement on that coast, and the entire success of the home product is each year more fully assured.

*Colorado.*—There was only one plant producing Portland cement in Colorado in 1904, and this plant had a much larger output than that recorded for the preceding year. This company, it will be remembered, absorbed its only competitor in the State in 1902, and increased its own capacity greatly thereafter. There is now another company in Colorado that has at present some facilities for burning cement, and the writer is informed by them that the erection of a large, modern Portland cement plant is contemplated in the near future. As about 85 per cent of the cement made in the United States is manufactured



east of the Mississippi River, and as the freight rates on cement shipped to the west from eastern factories are heavy, there should be sufficient room for a number of new cement mills in Colorado, where raw materials for the industry are abundant.

*Illinois.*—There were four active Portland cement factories in Illinois during 1904, and one factory which remained idle on account of the condition of the cement market. Of the four active plants, two were closed down three months for repairs, and the other two ran on full time throughout the year. The Illinois Steel Company did not complete its new plant at Buffington, Ind., in time to manufacture cement, until January, 1905. This plant is more fully described as to its location in the detailed account of the State of Indiana; though that it is built just across the State line dividing Illinois from Indiana, instead of just within it, is a mere chance and due to the fact that at the time when the building of an additional plant was desirable, there was no other land available for purchase by the Illinois Steel Company which was as near to its mill at South Chicago as the site at Buffington. The enterprise and the capital invested in the Indiana factory belong entirely to Illinois. The three other cement plants in this State produce only natural-rock cement.

*Indiana.*—The Portland cement industry was fairly prosperous in this State in 1904, notwithstanding the uncertain market, and the three plants which contributed to the total production had a larger output than they had in 1903. All three of the mills ran practically without interruption through the entire year. The plant at Mitchell was not closed down at all, and the company owning it expects to build a second factory there in 1905, still further to increase its Indiana production of cement. The plant at Bedford is now in operation and is to be active through the current year. It was not started up until just after the close of 1904. It has a capacity of 2,000 barrels of Portland cement per day, and the limestone and shale used for manufacturing are both to be had on the grounds where the mill stands. The new plant erected at Buffington by the Illinois Steel Company is located just without the Illinois State line, instead of just within it, as are the two other plants owned by the company. The factory is completed, and was started up in January, 1905. It has sixteen rotary kilns, each 80 feet long by 7 feet high at the fire end and 5 feet 6 inches at the stack end, capable of turning out sufficient clinker to make 4,500 barrels of Portland cement per day. Power for the electric motors is supplied from the South Chicago works, 10 miles distant, at less than a 4 per cent loss. The current is supplied by two 2,000-kilowatt generators, and steam is furnished by boilers fired with waste gases from the blast furnace in South Chicago. As in the company's slag-cement factory at North Chicago, Ill., and its Portland cement plant at South Chicago, Ill., the raw materials used are obtained in



the State of Illinois, the same quarry furnishing limestone for all three of the plants. The railroad used in shipping material from Chicago to Buffington also belongs to the company owning the cement plants. Therefore, although it is necessary, in order to preserve the integrity of this report as to totals of State production, to credit the cement manufactured at Buffington to Indiana, yet the fact that this new plant is but the third branch of a large Illinois company and that all the raw materials used, as well as the money invested, come from that State, should not be overlooked.

There are four other Portland cement companies reporting from Indiana besides the natural-rock cement producers. Of these four, one has dissolved, one has gone into the hands of a receiver, and one has not yet been satisfactorily capitalized, though there is a good prospect that it will be in the coming year. The fourth company is one which will build a Portland cement plant at Speeds. As yet only the preliminary work has been done, but the factory will probably be finished in 1905. It will have two rotary kilns, which will give a capacity of from 500 to 600 barrels of cement per day. Ball and pebble mills for both raw materials and clinker will be installed. Cement will be produced from the limestone underlying the natural cement rock in a quarry owned by this company, and from a shale which lies about 3 miles west of the quarry. The shale is to be brought to the plant by means of a narrow-gauge railroad built for that purpose.

*Kansas.*—For the first time Kansas has more than one cement plant devoted exclusively to the manufacture of Portland cement. The first plant to produce that article in the State was that of the Iola Portland Cement Company, whose first output was made in 1900. The second plant, that of the Kansas Portland Cement Company, has its first record for producing Portland cement in 1904. Its mills, which have a capacity of about 1,200 barrels per day, were started in February, and the plant continued to operate during the rest of the year. It is well located from an economic standpoint. The raw materials used in producing cement are obtained near the mill, and natural gas is the fuel used. The result of the first year was unusually good. There are two Portland cement plants now under construction in this State, and if the conditions in the cement world justify such a step they will both be completed and in active operation before the close of 1905. The other and older plants in Kansas produce only natural-rock cement.

*Kentucky.*—This State, for so many years associated with cement only as a producer of and selling center for the famous natural-rock product known as Louisville cement, has now a completed plant for the production of a first-class Portland cement. The factory is located at Kosmosdale, which was formerly known as Riverside, and is only a few miles from Louisville, in which city are the company's offices. The



raw materials used are limestone and clay; the quarry whence the limestone is obtained lies near the Ohio River, about 30 miles above the plant, and the limestone is brought to the mills by means of river transportation, and the clay beds, which show clay of unusual excellence, underlie the plant itself and extend over more than 800 acres of adjacent land, all of which is owned by the company operating the cement plant. Pulverized coal is the fuel used, and it also is brought to the mills by river transportation. The buildings of the entire plant are substantial, being of structural steel walled in with cement mortar on expanded metal, and making a construction which is practically fire-proof. There is also an especial provision for clinker storage, which is regarded as valuable, since the ripening of clinker is known to play an important part in the constancy of composition in Portland cement. Electric power is used for driving the machinery and for lighting many of the houses built by the company for its employees. These houses are of concrete construction. As at present completed, the plant has a producing capacity of 2,500 barrels of cement per day, but it is the intention of the owners to increase this capacity to 5,000 barrels per day in the near future, and the buildings have been constructed with a view to such an extension. Philadelphia capital is back of this enterprise, and the plant is said to have cost nearly a million dollars. At the time of the writer's visit to Kosmosdale the buildings and factory were incomplete, but at the present time [May, 1905] they are finished and the mills are in operation.

*Michigan.*—Of the sixteen Portland cement plants in this State in 1904, thirteen produced the output of cement for the year. One of the plants was not completed until June, and several of the older plants were shut down for a much longer period than is usual during the winter. One plant had a disastrous fire and was closed more than half the year, in order to rebuild, and another was compelled to close down while the machinery was undergoing necessary repairs. Another company closed its mills for several months, in order to make extensive improvements, and several factories were closed because of low prices, lack of orders, and overproduction. Notwithstanding these facts Michigan holds her place as the third largest producer of Portland cement in the United States, and her production for the year is in excess of that for the preceding year. There are several companies in this State that report that they are about to build cement plants, and there are a number of new plants, now practically complete, which have not been started up. One factory is in the hands of a receiver; and one company reports that its project is abandoned, and that the money subscribed has been paid back. The writer desires to call attention to the fact that on page 32 of the pamphlet upon the production of cement in 1903, issued by this Bureau in 1904, there is a line mentioning the name of the White Star Portland Cement Com-



pany as being among those companies which had abandoned the intention of building cement plants. Later information received from this company states that such is not the case; that the intention to construct a factory still exists, and that the company is still pursuing its enterprise. This company should properly come under the head of those whose projects have not yet taken the material shape of a cement factory.

A plant reported as one which will be completed late in 1905 or early in 1906 is that of the Standard Portland Cement Company. This organization owns 3,000 acres of marl lands in Benzie County, besides owning about 1,000 acres of limestone and cement rock property in Charlevoix County. The first project was to utilize the marl in producing Portland cement, but having become convinced that the rock process of manufacture would be a less expensive one the company decided to build a cement plant on the lands near Charlevoix and to make cement from limestone and shale. The holdings of the company include shale lands in Charlevoix County. Several large limekilns are also being built, as it is the present intention of the company to produce lime as well as Portland cement.

*Missouri.*—The two factories which made Portland cement in this State in 1904 were both active throughout the year, save for some trifling interruptions for necessary repairs. The output was in advance of that for the previous year. The plant at Louisiana is still in process of construction, and its completion will hardly be accomplished before the close of 1905. It is now expected by the owners that the mill will be started in January, 1906. There is no production of natural-rock cement in this State, and it is only within the last three years that any kind of hydraulic cement was produced here.

*New Jersey.*—The record for New Jersey in 1904 does not vary greatly from that for 1903. There were seven companies reporting, but of them only three were cement producers. Of these three, two ran ahead of their production for the previous year, and one fell behind. Of the others, two had not yet completed their plants; one was idle; and one had given up its organization and abandoned its intention of building a factory, at least for a time. The plant at Stewartsville again suffered from fire in its coal building, caused, presumably, by a bit of oily waste which took fire while going through the drier with the coal. It then dropped into the bottom of an inclosed elevator and set fire to the coal, which generated gas until the casing was filled, when it exploded. This is a much more unusual cause for fire or explosion than the cause which led to the same results in 1903. To avoid a recurrence of either accident, the coal at the plant is not now dried with direct heat, but by means of steam instead. It is the present intention of the company owning this plant to increase its capacity to 5,000 barrels of cement per day during the latter part of 1905. The



State production of New Jersey again shows an increase over that for the preceding year.

*New York.*—Three of the twelve companies that produced Portland cement in New York State in 1904 also produced natural-rock cement, and nine companies manufactured Portland cement exclusively. Several of these nine companies were idle the greater part of the year, and a number of them closed down their plants for shorter periods of time. Among the many causes that entered into the shutting down of plants in this State during the year were bad market conditions, lack of orders, some installations of new machinery, low prices of cement, legal complications, low water, labor troubles, coal shortage, full storage bins, and fire. One plant which has reported a production of cement for many years was idle throughout the year, overhauling the mills and preparing to install rotary kilns instead of the upright kilns, in which heretofore the Portland cement has been burned, and one plant was sold outright. The factory at Wayland was burned down on Christmas Day, the plant being totally destroyed. The origin of the fire is unknown, and the loss is about \$140,000, only a part of which is covered by insurance. It is not yet decided whether the plant will be rebuilt or not. The number of factories engaged in the manufacture of Portland cement in New York was the same in 1903 and 1904, but the quantity of cement produced was less in 1904 than it was during the preceding year. A large iron company in the State now contemplates the erection of a mill for the production of slag cement, in order to make use of the slag from the foundry. This plan has not yet been definitely decided on, however.

*Ohio.*—The decline in the cement market throughout the year 1904 affected the production of cement in Ohio, although the Portland cement manufactured for that year was more than that produced in 1903. The plants which were closed down for repairs and new machinery were not opened again as speedily as possible, and one plant remained idle during the entire year because of low prices. There were seven factories in operation, all of which produced Portland cement exclusively. The two plants producing slag cement were active, as was the only factory in the State which produced natural-rock cement. The new plant of the Wellston Company, which took the place of that destroyed by fire, was started up in July, and in November it was found necessary to close it down in order to install additional machinery and engine power. The quarry belonging to this company is at Oretton, about 16 miles from Wellston, and here limestone and coal are mined from the same hill. The shale, too, is immediately adjacent. The company owns a very large and valuable tract of land containing almost unlimited deposits of materials well adapted to the production of an excellent Portland cement, and the



erection of another large plant, to be located at Oreton, is being considered.

*Pennsylvania.*—The number of mills operated for the production of Portland cement in this State in 1904 was seventeen, and the quantity of cement produced was an increase of nearly 2,000,000 barrels over the quantity manufactured in 1903. Five of the seventeen active factories produced both natural rock and Portland cement. Two companies that had reported themselves in 1903 as about to build cement factories abandoned their plans entirely in 1904. Three plants were idle during the year, and five are reported as being under construction and likely to become active producers in the near future. The National Portland Cement Company's plant at Martins Creek, which was not completed in 1904, will probably be active in 1905. It is a large plant, extending over more than 5 acres of ground. There are already installed sixteen rotary kilns, each having a capacity of 200 barrels per day. The factory is well equipped for transportation, being located near the Pennsylvania; the Delaware, Lackawanna and Western; and the Lehigh and New England railroads. Electric power is used throughout the plant. The new mill at Penn-Allen was started up about the middle of the year, and made a very satisfactory production during the remaining six months. Several of the active plants ran all the year, but the majority of those reporting a production of cement for 1904 also report idleness for some part of that year, ranging from periods of one to ten months in length. A comparison of the values of the total State productions for 1903 with 1904 will show that the falling off in prices of Portland cement struck most heavily upon the eastern market. The 9,754,313 barrels of cement produced in Pennsylvania in 1903 had a value of more than \$11,000,000, while the more than 11,000,000 barrels of cement made in 1904 sold for less than \$9,000,000.

*South Dakota.*—There is but one cement plant in South Dakota, and it is devoted exclusively to the production of Portland cement, using as materials for manufacture chalk and clay. In 1904 this factory did not have a production, owing to an entire remodeling of the plant and the installation of more modern machinery than that heretofore used. The five vertical kilns heretofore used in this mill are now replaced by four rotary burners, each 100 feet in length and 7 feet in diameter, and in place of millstones in the grinding department six Kent grinding mills have been set up. Coal drying and grinding machinery has been put in and the boiler capacity doubled. Under the present process of manufacture coal will entirely replace the coke formerly used, and an increase of about four times the former average output is confidently anticipated by the company in 1905. There was in 1903 a project to erect a second cement plant in another part of



South Dakota, but the organizers of the plan report postponement of their enterprise until such time as better prices are established in the cement market.

*Texas.*—In 1904 one of the three cement plants in this State was idle, one was closed nearly half the year but produced a large quantity of Portland cement during the remaining months, and the third manufactured both natural-rock and Portland cement. This plant was closed down during a part of the year. The activity of the factory purchased by a Kansas company and remodeled during the previous year materially increased the total State production.

*Utah.*—The output of Portland cement made by the single cement plant in Utah was more than twice as large in 1904 as it was in 1903, notwithstanding the fact that it was shut down for several months during 1904. In 1903 the plant was rebuilt and its capacity increased, so that the mills now have four rotary kilns, two of which are 60 feet and the other two 50 feet in length.

*Virginia.*—The report of this State in 1904 is practically a repetition of its report for 1903 except for the increase in production. The only plant producing Portland cement had a very successful run and was active all the year, with the result that its production showed a marked increase over that for 1903. This company uses limestone and shale as its raw materials, and has now ten active rotary kilns, 60 feet long by 6 feet in diameter. There are no new plants reported, and the only other factories in the State manufacture only natural-rock cement.

*Washington.*—The plant for producing Portland cement in the State of Washington is still a probability, though a large tract of land has been purchased near Seattle for this purpose. If in 1905 the increased demand for and higher prices of cement materialize, it is not unlikely that the cement plant which has been promised in this State for some time past will be built, and that Washington will enter the field as a competitor in the great northwestern section of the United States where the demand for cement so far surpasses the local supply.

*West Virginia.*—All of the Portland cement made in this State in 1904 was the product of one factory. Unfortunately this plant had a disastrous fire during the year and was closed down for a little more than six months in order to rebuild and put in some improvements. Even taking this into consideration, however, the factory made a very satisfactory production. The other Portland-cement plant in the State was not started up at any time during the year.

#### MATERIALS USED FOR PORTLAND CEMENT.

Portland cement in the United States is manufactured from a variety of materials, all of which, in proper chemical combinations, give practically the same resulting product.



These materials are limestone, marl, chalk, argillaceous limestone or cement rock, slag, shale, and clay, which should be so proportioned as to produce a mixture that will come within the prescribed bounds from which a good Portland cement may not depart. Following is a table showing the quantity and value of cement made from the use of these materials and the number of companies using the various kinds in 1904:

*Table showing materials used in making Portland cement in the United States in 1904.*

Materials used.	Number of companies.	Quantity.	Value.
		<i>Barrels.</i>	
Limestone and cement rock .....	21	13,902,939	\$10,733,588
Limestone and shale .....	18	5,631,686	4,937,740
Marl and clay .....	17	3,332,873	3,585,113
Limestone and clay .....	17	3,141,010	3,546,532
Limestone and slag .....	3	497,373	552,146
Chalk and clay .....	2	Idle.	.....
Total .....	a 78	26,505,881	23,355,119

a The five mills not included in this number were either new or inoperative in 1904.

The two plants using chalk as the calcareous material for their cement were both idle in 1904. One of them was remodeled and improved. It is probable that both will be active in 1905.

The figures showing total production of Portland cement in the United States have steadily grown larger during the last decade. The amount of increase shown each year as compared with the previous year is not so large in 1904 as it has been at any time within the three preceding years, as illustrated by the following table:

*Production of Portland cement in the United States, with yearly increase, 1895-1904.*

Year.	Quantity.	Increase.	Percent- age of increase.
	<i>Barrels.</i>	<i>Barrels.</i>	
1895.....	990,324	191,567	24.0
1896.....	1,543,023	552,699	55.8
1897.....	2,677,775	1,134,752	73.5
1898.....	3,692,284	1,014,509	37.9
1899.....	5,652,266	1,959,982	53.1
1900.....	8,482,020	2,829,754	50.1
1901.....	12,711,225	4,229,205	49.9
1902.....	17,230,644	4,519,419	35.6
1903.....	22,342,973	5,112,329	29.7
1904.....	26,505,881	4,162,908	18.6

## NATURAL-ROCK CEMENT.

The manufacture of natural-rock cement, which is the oldest cement industry known, was materially decreased in the United States in 1904 by the unprecedented fall in the selling prices of Portland cement. The great difference which has existed between the cost of natural-rock cement and that of Portland cement has hitherto operated in favor of the former, while it has not proven detrimental to the latter. There are many purposes for which the natural-rock cements are equally as good as the artificial product, and in such cases the lower price of the natural-rock article has given it the preference. But when the price of Portland cement fell to a rate scarcely any higher than that at which a first-class natural-rock cement could be purchased the sales of the latter cement naturally decreased. Hence the reduced output of natural-rock cement in 1904. As the process of making artificial cements involves a greater outlay of capital, both for the construction and running of a plant, than that required for the manufacture of natural-rock cement, it is, of course, quite proper that the price should be proportionately higher.

## PRODUCTION.

In 1904 the total production of natural-rock cement in the United States amounted to 4,866,331 barrels, valued at \$2,450,150, which figures show a falling off of more than 2,000,000 barrels in quantity and of about \$1,225,000 in value, as compared with the respective figures for 1903. The same conditions which operated to reduce the production in 1903 prevailed to even a greater extent in 1904.

In arranging the following table, which shows the quantity and the value of natural-rock cement manufactured in the United States in 1904, by States, it has been thought best to make a slight change in the form which has heretofore been used in preparing these reports. This change consists in separately reporting the productions of cement made by the States of Kentucky and Indiana, which productions have heretofore been reported together. In the earlier reports made by this Bureau, when the only production of cement reported by these two States was the natural-rock product made in what is called the Louisville district, embracing territory on each side of the Ohio River and lying in both Kentucky and Indiana, no confusion resulted from such a conjunction of the two States.

But since the marked development of a Portland cement industry in the northern part of Indiana, the building of a large plant for the manufacture of Portland cement in Kentucky near Louisville, the breaking of ground for a Portland cement plant near Sellersburg, Ind., and the projecting of other Portland factories immediately within the Louisville district both in Kentucky and Indiana, the recording of the



two States separately seems advisable. Following is the table showing the quantity and value of the natural-rock cement manufactured in the United States in 1902, 1903, and 1904:

*Production of natural-rock cement in 1902, 1903, and 1904, by States.*

State.	1902.			1903.			1904.		
	Num- ber of works.	Quantity.	Value.	Num- ber of works.	Quantity.	Value.	Num- ber of works.	Quantity.	Value.
		<i>Barrels.</i>			<i>Barrels.</i>			<i>Barrels.</i>	
Georgia.....	2	55,535	\$31,444	2	80,620	\$44,402	2	66,500	\$37,750
Illinois.....	3	607,820	156,855	3	543,132	178,900	3	360,308	113,000
Indiana.....							13	735,906	367,953
Kentucky.....	15	1,727,146	869,163	15	1,533,573	766,786	2	264,104	132,052
Kansas.....	2	160,000	80,000	2	226,293	169,155	2	210,922	79,456
Maryland.....	4	409,200	150,680	4	269,957	138,619	4	65,000	32,500
Minnesota.....	2	150,000	67,500	2	175,000	78,750	2	138,000	65,620
Nebraska.....							1		
New York.....	19	3,577,340	2,135,036	20	2,417,137	1,510,529	19	1,911,402	1,138,667
North Dakota..	1			1			1		
Ohio.....	2			2	67,025	46,776	1		
Pennsylvania..	6	796,876	340,669	7	1,339,090	576,269	5	770,897	298,533
Texas.....	1			2			1		
Virginia.....	2	34,000	20,000	2	47,922	25,961	2	93,292	59,619
West Virginia..	1	88,475	62,655	1			1		
Wisconsin.....	2	437,913	162,628	2	330,522	139,373	2	250,000	125,000
Total.....	62	8,044,305	4,076,630	65	7,030,271	3,675,520	61	64,866,331	2,450,150

<sup>a</sup> The States combined for 1902 and 1903 are noted in the text of the reports for those years.

<sup>b</sup> The States wherein the cement product was combined with that of some other State for 1904 are given in the text below.

The combinations of figures showing State totals of production of natural-rock cement in 1904 are more numerous than those for 1903. In the latter year only the North Dakota figures were recorded in combination with those for two other States, but in the record for 1904 it has been found advisable to combine the figures for North Dakota with those for Minnesota, the figures for Ohio with those for Virginia, and the figures for Texas with those for Kansas. As heretofore, the final statement of the combinations is placed against the name of that State which contributed the largest proportion of cement to the total quantity.

New York has always been the largest producer of natural-rock cement in the United States, and that record remains unchanged in 1904, the returns showing this State to be the only one that produced more than a million barrels.

If the Louisville district had been reported as a whole in 1904 that locality would have occupied second place as a producer of natural-rock cement, as heretofore. But since it has seemed best to divide this district, Pennsylvania holds second place, but exceeds by less than 35,000 barrels the production of Indiana, which stands third in rank.



## THE NATURAL-ROCK CEMENT INDUSTRY, BY STATES.

The States mentioned below were not all active producers of natural-rock cement in 1904. There are seventeen States having factories capable of producing such cement, but some of them did not contribute to the total production during the year. Following are the detailed accounts of State production:

*Florida.*—There was no production of cement in this State in 1904, and the outlook was not sufficiently encouraging to the people interested in the reorganization of the company at River Junction to admit of much development of their plans. The material at this place, which is so well adapted to the manufacture of cement, was described by Mr. Uriah Cummings in 1898 as follows:<sup>a</sup>

Probably the most remarkable natural hydraulic cement rock deposit in the known world occurs near River Junction. From this point the deposit extends for several miles along the left bank of the Appalachicola River, southerly to Aspalaga. On a recent visit to this locality the writer made a careful estimation of this truly remarkable formation. It comprises something over 2,000 acres, and has a thickness of 80 feet above the river. How far it may be below has not been ascertained. Enough is exposed, however, to warrant the assertion that the deposit contains sufficient raw material to produce over two billions of barrels of cement. The material is usually soft enough to cut with a spade, but the lumps, when placed in kilns, harden sufficiently to prevent them from crumbling while undergoing calcination. Several analyses of samples taken from various parts of the formation show a remarkable uniformity of proportions of the ingredients essential to the production of a first-class hydraulic cement. But the distinguishing feature of this deposit consists in its perfect purity of color. The raw material is white, and the manufactured product is as white as the whitest marble. In this respect it is an ideal cement for the architect, as it will not stain the walls of fine masonry. Bricks made of one part of this cement and two parts white sand are in use in many buildings in the South, and they are extremely hard and beautiful. So far as is known to the writer, this is the only deposit of white hydraulic cement material in the world.

*Georgia.*—There are two plants in Georgia which produce natural-rock cement, and both were in operation during the year. Their combined production was smaller than that for the previous year, and both mills were closed for a short time in order that repairs might be made, and because of the restricted demand for cement. One of these factories is devoted exclusively to the producing of natural-rock cement, while the other is equipped to make both natural-rock and Portland cement. In 1904, however, it had no output of Portland cement, the mills being used only in the manufacture of natural-rock product.

*Illinois.*—Among other causes which contributed to the reduced production of natural-rock cement in this State in 1904 were strikes by the labor unions that affected the three cement mills. All of these plants were closed down for a number of months, and the output of cement fell materially below that for the preceding year. Of these

<sup>a</sup> Cummings, Uriah, American Rock Cement: Ann. Rept. U. S. Geol. Survey, pt. 6 cont., 1899, pp. 549-550.



plants, the two older ones are run under practically the same management, though they are two entirely distinct and separate organizations in every respect. They have both been remodeled, and have had new grinding machinery installed within the last two years, so that the output of both plants is now ground and pulverized by Smidth ball and tube mills and comminutors, and thus reduced to practically the same fineness as Portland cement. The improved cement from these mills is regarded as one of the best natural-rock cements on the market. The other plants in the State make only Portland cement.

*Indiana.*—In the State of Indiana there are thirteen mills which were built for the manufacture of natural-rock cement. In 1904 many of them were idle, owing to conditions which have existed for several years in the Louisville district, and which resulted in the formation of a company to control the manufacture and the selling of Louisville cement and to regulate the quota assigned to each mill. In many cases the quota of smaller factories is made for them by one of the large plants, in which event the small place is not started up at all. The general depression in the cement business affected this district as it did other cement-producing localities, and the output was more than half a million barrels short of the quantity produced by the same mills in the previous year. The fall in values was likewise extreme. It is reported to this Bureau by a large manufacturer of natural-rock cement in this district that he is about to build a modern, well-equipped plant for the production of Portland cement during 1905. If the present plans for this plant are carried out the factory will be started up in the late fall or early winter of 1905. It will not, however, interfere with the operation of the plant for producing natural-rock cement.

*Kansas.*—One of the two natural-rock cement plants in this State suffered from a destructive fire in December, 1903, and was idle for about three months early in the year of 1904, during which time the factory was rebuilt. In the fall there was another temporary shut-down at the plant by reason of overproduction. The other plant ran throughout the year, but not at full capacity. In Kansas the natural-rock cement industry is an old and well-known one, while the production of Portland cement there dates only from 1900.

*Kentucky.*—In this State the two natural-rock cement plants are situated in the suburbs of Louisville, between the canal and the river, and the rock used by them in making cement is obtained from the ledge of hydraulic limestone which rises out of the river and upon which they are built. They are exceedingly interesting plants. They have a barrel manufacturing department, which is adjacent to and run in connection with the mills, and in which the barrels used for cement shipments are made. The cement rock is burned in the ordinary top-fire, vertical kilns, which are about 30 feet high, and for transporta-



tion the river, the canal, and the railroads are immediately adjacent to the mills.

*Maryland.*—There were only two plants in this State which produced cement in 1904, and they made a very much smaller quantity than was produced by them in the preceding year. A third plant, which has contributed for years to the natural-rock cement production of Maryland, was idle throughout the year because of the low price of Portland cement and the consequent lack of orders for the natural-rock product. The plant located at Hancock, which for two years past has been idle, changed hands in 1904 and is now being remodeled and equipped with the most modern machinery available for the manufacture of natural-rock cement. Materials on the land owned by the new company are under examination to determine whether they are suitable for use in the manufacture of Portland cement. If they are found to be suitable for this purpose, and if the economic conditions are satisfactory, a plant for the production of Portland cement will be erected by the Round Top Company. The cement which for years was manufactured at this plant was known as a reliable article, and was used in the construction of the base and of the first 40 feet of the present Washington Monument, at Washington, D. C.

*Minnesota.*—The two cement plants in Minnesota manufacture only natural-rock cement, and in 1904 both of them reported productions. In one mill the output ran ahead of that for the previous year, and in the other it fell behind. These plants have both been successfully operated since they first manufactured cement. One of them is about twenty-five years old, and the other was opened in 1895. There are abundant materials in the State for the manufacture of a first-class Portland cement, and plans for their development have been reported to this Bureau.

*Nebraska.*—The single cement plant in Nebraska was idle in 1904, as it has been for several years past. When active, its production was of natural-rock cement only.

*New York.*—The State of New York is the well-known center of the natural-rock cement industry, and has been such for more than three-quarters of a century. In 1904 the total production of this article was much smaller than that for the preceding year, owing principally to the low prices already mentioned. There were, however, several minor causes, among which were labor troubles, low water, and closing down for unavoidable repairs. Several plants stood idle through the entire year, for lack of enough orders to pay for starting the factories. Sixteen of the nineteen companies reporting a production of natural-rock cement were engaged in the manufacture of that product exclusively, and the remaining three manufactured both Portland and natural-rock cement. The outlook for manufacturers of cement in this State is encouraging at present, because of the large



quantities of cement required in the construction of the canal which is to connect the Great Lakes with the Atlantic Ocean by traversing New York State.

*North Dakota.*—The single cement plant in North Dakota was active only about half the year in 1904. Difficulties in transportation, caused by the severe winter, were responsible. The tests for this particular brand of natural-rock cement run especially high, and the cement has a reputation for being generally satisfactory.

*Ohio.*—In 1904 Ohio had but one plant used for the production of natural-rock cement. This factory ran ahead of its output for the previous year and was closed during the year only for holidays and occasionally for slight repairs. The other two plants which in former years were producers of this variety of cement both remained idle. Besides these there are two slag cement plants in the State, and the rest of the mills manufacture Portland cement only.

*Pennsylvania.*—There were no mills making natural-rock cement only in Pennsylvania in 1904, and all production of such cement came from the five factories having an output of both Portland and natural-rock cement. This production was much smaller both in quantity and in value than that for 1903. The causes which led to such results were practically the same as those which affected other States in the same way. There are in Pennsylvania several new factories under construction and some old ones are being remodeled. Two companies went out of business in 1904 and three were idle all the year.

*Texas.*—The cement plant at San Antonio, Tex., which produces both natural-rock and Portland cement, ran during the most of 1904, and had a good output, although its production of natural-rock cement was not so large as that for 1903. The only other plant which is equipped for the manufacture of natural-rock cement was idle all the year. The third plant in the State was originally a producer of natural-rock cement, but was sold and remodeled in 1903, and in 1904 had a large production of Portland cement.

*Virginia.*—The State of Virginia did not greatly change her record in 1904 from that made in 1903. In 1904 there were two natural-rock cement plants operating, one of which ran ahead of and one behind the respective outputs for 1903; but the shortage of one was so much less in quantity than the increased production of the other that the total State production shows an advance when compared with that of 1903.

There was one active Portland cement plant in the State in 1904, and one plant which remained idle all the year.

*West Virginia.*—With the exception of the plant which had a production of Portland cement in this State in 1904 there were no cement factories operating in West Virginia during the year.

There are three other plants located in the State, all of which have been producers of good brands of natural-rock cement. An increase

in the demand will doubtless result in at least two of the three becoming active in 1905. The third plant is for sale, and will not be operated by the present owner.

*Wisconsin.*—In 1904 there were two cement plants in Wisconsin which were operated to produce natural-rock cement, and two new companies were formed to build cement plants. The two active factories had a combined production that was not equal to their combined output for 1903, and both were shut down during the winter months. In one of the mills, repairing a damaged shaft caused a longer shut down than usual. These are the only cement plants in Wisconsin.

#### CEMENT ROCK QUARRYING AND MINING.

In the chief districts for the production of natural-rock cement, such as the Louisville and the Rosendale districts, two very different processes for obtaining the cement rock are used. The method used in getting out the cement rock from which Louisville cement is made is by blasting or quarrying out the rock. After being tested the rock is stripped and holes are made with steam drills at points of a proper distance apart to result in such an explosion as shall give as large a proportion as possible of pieces of rock sufficiently small in size for use in the kilns without further breaking. These holes are then charged with dynamite and simultaneously exploded by means of an electric battery. The pieces of rock which are small enough are then selected and loaded into small cars for transportation to the kilns. Such pieces as are too large for the kilns are left to be broken up with sledge hammers before going to the cars, except in quarries where a rock crusher is used, in which case they are loaded for transportation to the crusher.

The process of mining the rock is also used in the Louisville district, though it is usually resorted to only when the great depth of earthy deposit above the cement rock makes stripping unprofitable. The mills are almost evenly divided in number as to the process used, and several plants use both processes.

In the Rosendale district practically all of the rock is mined or tunneled, and not quarried. The mines are generally worked on the slope and the rock is brought to the surface by rope haulage. This process is more expensive than quarrying, but the formation of the rock in this locality necessitates it. As Rosendale cement is the oldest and best known of the natural-rock cements now on the market, it has been successful notwithstanding the expensive mining.

#### PUZZOLAN OR SLAG CEMENT.

Of names given to the three varieties of hydraulic cement now produced in the United States two, it will be observed, originated in geographical localities.



The name "Portland" was given to his cement by Joseph Aspdin, of Leeds, England, who in 1824 obtained a patent for a material which in his specifications is described as Portland cement, because of its resemblance in color to the well-known grayish-blue building stone quarried from the peninsula of Portland, on the coast of Dorsetshire, England.

Pozzuolana is the name of a rock possessing the properties of hydraulic lime or cement, found in the vicinity of the village of Pozzuoli, near Naples, Italy, where it was first discovered. It is said to have been used extensively by the Romans in making cements and mortars. As several forms of this word have been used in the business world, doubtless with a view to contracting an unquestionably clumsy name, it seemed proper to secure an expression of some opinion as to the form most commonly used among the manufacturers of slag cement in this country. This was accordingly done in 1904, and as a majority of those whose opinions were requested showed a preference for the name as it is used at the head of this paragraph, i. e., Puzzolan, that form has been adopted for official use in this Bureau.

#### PRODUCTION.

There were in 1904 but two States which had more than one plant for the production of Puzzolan, or slag cement, and hence it is not yet possible to publish a table giving full details of production in each State. To avoid the disclosure of individual figures, therefore, Alabama and Illinois are combined in the following table to make a total which is set against Alabama, as the two plants in that State gave it the greater production; and Maryland, Ohio, and Pennsylvania are combined, with the resulting total placed against Ohio, since the two plants in that State also gave her the largest production. New Jersey produced no slag cement in 1904.

Below is a table showing total production of slag cement in the United States, together with the number of factories in each State:

*Production of slag cement in the United States in 1903 and 1904, by States.*

State.	1903.			1904.		
	Number of works.	Quantity.	Value.	Number of works.	Quantity.	Value.
		<i>Barrels.</i>			<i>Barrels.</i>	
Alabama.....	2	.....	.....	2	187,677	\$141,402
Illinois.....	1	.....	.....	1	.....	.....
Maryland.....	1	.....	.....	1	.....	.....
New Jersey.....	1	.....	.....	1	.....	.....
Ohio.....	1	.....	.....	2	115,368	85,249
Pennsylvania.....	1	.....	.....	1	.....	.....
Total.....	7	525,896	\$542,502	8	303,045	226,651



## THE PUZZOLAN OR SLAG CEMENT INDUSTRY BY STATES.

Detailed accounts of the States which in 1904 contributed to the total quantity of slag cement made in the United States are as follows:

*Alabama.*—In this State there were two plants operated during the year to produce slag cement. They are owned by separate companies, but for several years past have been managed by one company, that held a lease of the second plant. The total production for the year was not so large as that for the previous year.

*Illinois.*—Of the three large cement plants now owned and operated by the Illinois Steel Company but one is used to produce slag cement. The other two mills use slag in combination with other materials, grinding and burning them together in crushers and rotary kilns, and thus manufacturing a true Portland cement. The two processes should not be confused. The use of slag and limestone as ingredients for Portland cement makes, when properly treated, a mixture that is chemically correct and meets all the specific requirements for a good Portland cement. In the production of Puzzolan, or slag cement, no burning in rotary kilns is done, and the finished product does not reach the requirements of a true Portland cement. The factory operated in North Chicago by the Illinois Steel Company is the only one producing slag cement in Illinois at the present time. It was operated only about half the year on account of a dull market and produced a much smaller output than that for 1903. The Portland cement plant at South Chicago ran the entire year.

*Maryland.*—The depression in the cement trade and the extremely low prices which prevailed in 1904 were felt by all producers of cement in the United States, but more especially by those in the Eastern States. Maryland, which produces only natural-rock and slag cements, was not an exception to this rule. The single slag cement plant in the State was active for a time, but its output was not a large one, and the mills of the cement department were closed down for nearly three-quarters of the year.

*New Jersey.*—No production of slag cement is reported from the plant in this State for 1904, the factory, which is located at Perth Amboy, being idle because of moving its site and of lack of demand.

*Ohio.*—This State, like Alabama, has now two plants which are engaged in making Puzzolan, or slag cement, as the new plant which was being built in 1903 became an active producer in 1904, despite the fact of its undergoing a somewhat destructive fire. The output of the two factories was creditable, though neither of them ran on full time through the year. Until 1904 Ohio has had but one slag cement mill.

*Pennsylvania.*—The one plant in Pennsylvania which produces slag cement was active in 1904 through about half of the year, and its pro-



duction was smaller than that for 1903. There is in this State another plant where slag and limestone are used as ingredients in producing cement. As, however, these raw materials are calcined in rotary kilns and the resulting clinker ground, and as the finished product meets every requirement of a Portland cement, this factory can not be numbered among the slag-cement producers.

#### VARIETIES IN BLAST-FURNACE SLAG CEMENTS.

In view of the fact that slag is now recognized as being a material of importance to the cement world, the following extract from Mineral Resources for 1887 is here given:<sup>a</sup>

Interest in cement made with blast-furnace slag as one of the ingredients seems to be rapidly gaining ground. The following, taken from London Engineering, is a brief account of some of the processes which involve slag as an ingredient:

"Three kinds of cement are made from blast-furnace slag. The first, which is really more of a mortar than a cement, is produced by grinding slag sand with 15 per cent of lime and 15 per cent of oxide of iron. The grinding is generally done wet and the product requires to be used within a few hours after being made, so that its employment is quite local. The second cement is made by grinding 75 per cent of dry slag sand with 25 per cent of dry slaked lime, according to Mr. Larsen's patent. It is essential that the ingredients should be finely pulverized and that they should be intimately commingled. For this purpose the inventor uses a machine which he calls a 'homogeneizer.' The third cement is made according to a process brought out by Mr. Frederick Ransome. Equal weights of slag, sand, and chalk are ground together in a wet state, and after being dried are burned either in a kiln or revolving furnace, the process followed being similar to that used in making Portland cement. The following table gives analyses of two of the cements we have mentioned and also of two examples of Portland cement:

*Analyses of cements.*

	Lime.	Silica.	Alumina.	Ferrie oxide.	Ferrous oxide.	Magne- sia.	Water.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
No. 1 slag cement .....	22.9	21.01	19.85	8.80	4	4.36	12
No. 2 slag (Larsen) .....	41.96	24.34	18.74	.14	.27	6.57	4.70
Portland (No. 1) .....	59.9	24.07	6.92	.....	.....	.....	.....
Portland (No. 2) .....	55.57	22.92	8.6	.....	.....	.....	.....
Middlesbro' slag .....	40	52.34	.....	.....	.....	.....	.....
Middlesbro' (No. 2) .....	36.88	51.12	.....	.....	.....	.....	.....
Middlesbro' (No. 3) .....	40.45	50.08	.....	.....	.....	.....	.....

The first and second analyses are by Mr. J. E. Stead. The nonessential ingredients are not given.

"From this it will be seen that the first two cements are widely different in their chemical constitution from Portland cement, and they are still more different in their physical condition, for the lime is mostly free, the materials not having undergone the incipient fusion which Portland cement experiences. Now, in the slag the proportion of lime to alumina and silica is about as 39:51, while in cement it is as 58:31; therefore 100 parts of slag, including the inert matters, require the addition of 56 parts of lime, or of 100 parts of dry chalk or limestone, to provide the constitu-

<sup>a</sup> Mineral Resources U. S. for 1887, U. S. Geol. Survey, 1888, p. 531.



ents of a good cement, and this is the mixture used in Ransome's process. The result gives a product which exceeds the strength of Portland cement, and which improves with age. Samples 7 years old are in existence, and show no signs of deterioration. Of course, the process is only commercially feasible in districts where slag is produced, but there it offers a means of turning a useless product into a valuable material, and, if it be carried out by Ransome's revolving furnace, the expense for plant is comparatively small."

The reference to "Ransome's revolving furnace" in the foregoing will readily be recognized as indicating the patent process for burning cement first invented by Frederick Ransome, from which the present 60, 80, and 100 foot rotary kilns are an evolution.

In 1904 several new processes dealing with methods for immediately chilling the slag in cold water were exploited. Among them is one for chilling the hot slag in cold milk of lime, thereby increasing the hydraulicity as well as the tensile and compressive strength of the resulting cement. The effort to improve slag cement is constantly being made by those interested in the use of slag as a base for the production of a good cement.

#### LOCATION OF CEMENT PLANTS.

The map printed herewith (Pl. II) is designed to show the general location of the cement plants in the United States at the present time. The great possibilities of the cement industry in the West, the large territory as yet not supplied with cement mills, and the proximity of plants to each other are seen at a glance. Only such mills as are already built and those so nearly completed as to be practically ready for operation are indicated. There are several plants, like the one in Nebraska and the one in Florida, which have been idle for a number of years. These plants are given place on the map, since they are located on or near well-known deposits of material suitable for use in the manufacture of cement, and are liable to become active producers whenever the companies owning them are reorganized or the demand for cement seems to justify their operation. There are companies reporting to this Bureau plants about to be built, so that within another year the number of mills may be decidedly increased; but these projects are not indicated on the accompanying map.

#### IMPORTS AND EXPORTS.

##### IMPORTS.

The total quantity of hydraulic cement imported into the United States for all purposes in 1904 was 1,046,293 barrels. Of this amount 968,410 barrels were entered for consumption in this country. The remaining 77,883 barrels were not consumed here. They may have been entered merely for transportation to some other country via America, or have been left unused in the warehouse, or they may have been sent to the United States for consumption and, upon arrival





LOCATION OF CEMENT PLANTS.



here, may have been more profitably or more quickly disposed of elsewhere. This explanation is made in order that no misunderstanding as to the figures showing imports which are used in the following tables may arise. In one table total imports of all hydraulic cements brought into this country for any purpose whatever are shown. In another only the imports actually withdrawn from the warehouse for consumption here are shown. In each case barrels of 400 pounds each are indicated.

Following is a table showing imports of all hydraulic cements into the United States, by countries:

*Imports of hydraulic cement into the United States in 1900, 1901, 1902, 1903, and 1904, by countries.*

Country.	1900.	1901.	1902.	1903.	1904.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>
United Kingdom.....	267,921	37,391	79,087	146,994	16,365
Belgium.....	826,289	303,181	615,794	737,576	394,368
France.....	32,710	11,771	14,922	14,866	34,912
Germany.....	1,155,551	560,596	1,259,265	1,377,414	585,439
Other European countries.....	75,827	19,078	18,654	27,415	7,538
British North America.....	4,517	6,066	3,612	4,421	580
Other countries.....	23,869	6,809	4,154	9,265	7,091
Total.....	2,386,684	944,892	1,995,488	2,317,951	1,046,293

#### RELATION OF DOMESTIC PRODUCTION AND CONSUMPTION TO IMPORTS.

In the following table the increase in the total quantity of Portland cement produced in the United States since 1890 is shown, as well as the decreased production of natural-rock cement, and the variations in the imported hydraulic cement consumed in this country since that year:

*Comparison of production of Portland and natural-rock cement in the United States with imports of hydraulic cement, 1890-1904.*

Year.	Natural cement.	Portland cement.	Total of natural and Portland cement.	Imports.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>
1890.....	7,082,204	335,500	7,417,704	1,940,186
1893.....	7,411,815	590,652	8,002,467	2,674,149
1895.....	7,741,077	990,324	8,731,401	2,997,395
1897.....	8,311,688	2,677,775	10,989,463	2,090,924
1898.....	8,418,924	3,692,284	12,111,208	1,152,861
1899.....	9,868,179	5,652,266	15,520,445	2,083,056
1900.....	8,383,519	8,482,020	16,865,539	2,321,416
1901.....	7,084,823	12,711,225	19,796,048	922,426
1902.....	8,044,305	17,230,644	25,274,949	1,963,023
1903.....	7,030,271	22,342,973	29,373,244	2,251,969
1904.....	4,866,331	26,505,881	31,372,212	968,410



In this table the production of Puzzolan or slag cement, which has been recorded elsewhere in the reports on the production of cement for 1901, 1902, and 1903, does not appear. It was as follows: 1901, 272,689 barrels; 1902, 478,555 barrels; 1903, 525,896 barrels, and in 1904, 303,045 barrels.

Following is a table showing a comparative statement of the production of Portland cement in the United States, with the total amount of imported hydraulic cement consumed in the United States in 1891, 1901, 1902, 1903, and 1904:

*Comparison of domestic production of Portland cement with consumption of all hydraulic cements, 1891, 1901-1904.*

	1891.	1901.	1902.	1903.	1904.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>
Production in the United States .....	454,813	12,711,225	17,230,644	22,342,973	26,505,881
Imports (entered for consumption) .....	2,988,313	922,426	1,961,013	2,251,969	968,409
Total .....	3,443,126	13,633,651	19,191,657	24,594,942	27,474,290
Exports (domestic).....		417,625	373,414	285,463	774,940
Total consumption .....	3,443,126	13,216,026	18,818,243	24,309,479	26,699,350
Percentage of domestic production to total consumption in the United States.	13.2	96.2	91.6	91.9	99.2

#### EXPORTS.

The matter of exporting cement from this country has not yet received the attention from American manufacturers that it has received in other cement-producing countries. America is the largest consumer of cement in the world, and in view of her increasing facilities for production, a statement of figures for the purpose of showing the quantity of domestic cement that has been exported from the United States during the last five years seems opportune. The figures used in the following table show only domestic exports. The total quantity of hydraulic cement exported in 1904, both domestic and foreign, was 814,551 barrels.

*Exports of domestic hydraulic cement, 1900-1904.*

Year.	Quantity.	Value.
	<i>Barrels.</i>	
1900 .....	100,400	\$225,306
1901 .....	373,934	679,296
1902 .....	340,821	526,471
1903 .....	285,463	433,984
1904 .....	774,940	1,104,086
Total .....	1,875,558	2,969,143



It is a fact that in case of an overstocked cement market in the United States, much relief might be afforded by the establishment of a substantial foreign trade. The freight rates at the present time are not prohibitive. On this subject Rock Products, in its issue for October, 1904, says:

There has not been any systematic effort made to secure the trade of foreign countries, it having been generally the belief that the American mills could not meet competition with the German cements, due to the alleged fact that the Germans enjoyed much lower ocean freight rates, possibly due to the subsidizing practice of foreign governments.

An investigation on this point proves that this idea is erroneous. American Portland cements, sold at a price which is from 10 to 25 cents per barrel (including export companies' profits) above the price which is now being quoted for domestic shipments, may successfully compete in South America, South Africa, Central America, West Indies, and at equal figures with that being quoted for domestic trade there, and can successfully compete in India, China, and the Philippines.

The freight rate from New York to South Africa is no higher than from Lehigh Valley mills to St. Louis at the present time.

Foreign cements are selling in South America and in South Africa at present, ranging from \$3 to \$5 per barrel, according to the quality, and right here it would be well to state that investigations carried on by the leading cement experts demonstrate beyond a doubt that there are high-grade Portland cements manufactured in the United States which are superior in every way to the highest grade of Portland cement manufactured in Europe.

The total consumption of hydraulic cement in the United States in 1904 was 31,868,727 barrels.

#### PRODUCTION OF CEMENT IN CANADA.

The depreciation in prices of Portland cement was evidently felt in Canada as well as in the United States, for while the total production of that article in Canada for 1904 is reported to be 222,617 barrels in advance of the figures showing total production of Portland cement in 1903, the increase in values in 1904 over 1903 is only \$107,150. There was in 1904 a further decrease in the production of natural-rock cement, which in 1903 fell behind the production for 1902.

The full figures for Canada's total production of cement in 1904 are 907,172 barrels, valued at \$1,247,389. Of this total, 850,358 barrels, having a value of \$1,197,992, are Portland cement, and 56,814 barrels, with a value of \$49,397, are natural-rock cement. In 1903 Canada produced 627,741 barrels of Portland cement, worth \$1,090,842, and 92,252 barrels of natural-rock cement, worth \$75,655.

The factories operating to produce Portland cement in Canada in 1904 used marl as raw material to furnish lime for their mixtures; but several new plants are being constructed with a view to the use of limestone. An abundance of this stone is known to exist in Ontario, and its composition has proven satisfactory, under analysis and test, for use in the production of Portland cement.



#### AVERAGE CHARACTERISTIC TESTS OF CEMENT IN THE UNITED STATES.

Although continued efforts have been and are still being made looking toward the establishing of more convenient and more uniform methods of testing cements, as yet no wholly satisfactory basis has been established. After a number of years of careful research and investigation the committee on uniform methods of tests of cement of the American Society of Civil Engineers have reported a set of rules governing methods of tests, which are the most complete and the best that have thus far been proposed. The gradual and almost universal adoption of these rules has made it possible to obtain far greater uniformity and concordance in results than have hitherto been obtained. But the absence of an absolute basis on which tests could be made with great uniformity should be considered in making a compilation of average results of tests from any set of statements sent in from the various cement mills, and the difficulty of arriving at a more than approximate average of the whole is at once apparent.

It is in response to many requests for a statement as to average characteristic tests of the cement produced from the various materials used in different parts of the United States that the accompanying table has been made.

The impossibility of exactly representing in such a table the quality of the cement manufactured throughout this country will be appreciated by anyone familiar with the compilation of tables showing tests of cement; and therefore this table is not intended to be absolute, but should be regarded simply as an effort to show the relative values and variations of the three classes of cement manufactured in the United States.

The qualities looked for in testing cement are soundness, fineness, uniformity of composition and burning, and strength; and while these are indicated to a large degree by the results of tests, yet there are many things entering into the making of a reliable cement which can only be touched upon in any table of tests in a most casual way. The imperfect preparation of raw materials, or a burning which is incomplete, may yield a product the quality of which is only partially, if at all, indicated in the test for specific gravity, while the cement can be adulterated to a considerable extent before it is disclosed by this test. The adhesive power of cement is very dependent on its fineness, the coarser portions of the powder being practically inert. Hence, the value of the tests for fineness, other things being equal.

The time of setting is stated in minutes in the table used here. The first or initial set of cement takes place when the mixture of water and cement ceases to be plastic; the final or hard set takes place when the mixture has acquired a certain degree of hardness, usually ascertained



with the well-known Vicat needle or some modification of it. The quickness with which the mortar is mixed and the dexterity with which the molding is done enter into the question of the ultimate strength attained by the cement, but can not, of course, be in any way brought into a tabulated statement of tests. The average tensile strength of the cement briquet, both neat and mixed with sand, is given in detail in the table as to strength attained in a given number of days. The results of these tests for tensile strength depend somewhat upon the kind of machine used in breaking the briquet, upon the care taken in keeping the clips free from dirt or sand, and upon the care used in placing the briquet in the clip in such a way that the strain will be evenly distributed. None of these things can be tabulated or indicated in a tabular statement, yet they are of importance.

Chemical analyses are made principally to determine what percentages of the different ingredients necessary for the manufacture of Portland cement exist in the mixture under test; also, they are often useful in revealing the presence of adulterants. It is necessary that the proportion of magnesia ( $MgO$ ) and sulphuric anhydride ( $SO_3$ ) be small, as in excess they are injurious. The percentage of water used in making the paste for pats or balls or briquettes for tests is of importance in many ways and materially affects the results obtained. The quantity of water used in mixing cement makes a difference in the density of the briquette and gives rise to variations in the tensile strength developed. For this reason it would be of interest to publish figures showing a characteristic average of this percentage. It was, however, impracticable to compile such a statement from the data forwarded by the manufacturers, as that point was not specially covered in the requests for data as to average characteristic tests sent out by this Bureau, and in only a few cases was it recorded. Owing to this fact the item has been omitted from this table altogether. There is nothing stated in the table as to the soundness of the cement used for the tests, because all of the tests were made with cement which had perfectly passed the usual tests for constancy of volume, viz, the immersion of pats in cold water, in boiling water, and in steam.

The tests for soundness differ in this country from those used in Germany, where the standard test is made by placing a pat of neat cement in water of a normal temperature for twenty-eight days. The objection to this test is the length of time it requires, and, while the cold-water test is used in the United States, the accelerated tests are more commonly made, as immersion of the pats in steam or boiling water usually reveals in a very short time evidences of unsoundness, if they exist, which would only be developed after a much greater length of time if cold water were used.

A few of the elements entering into cement testing, which can not be put into tabular form, are sufficiently indicated by these comments

to give a proper estimate of their value, and to lead to a consideration of them in using the tabulated averages. The figures used in preparing the tabulation have been almost entirely those furnished on request by the producers of cement in the United States. They have been arranged and averaged in accordance with the kind of material used in making cement, limestone and cement rock being the raw materials used in the Lehigh district. The subdivisions shown under "Portland cement" are extremely interesting, in that they seem to indicate that no matter what variety of raw materials are used, provided they contain the requisite ingredients and are properly treated in the process of manufacture, the resulting product will yield practically the same strength tests.

The following table shows average characteristic results of tests of cements in the United States.



Average characteristic tests of cement in the United States.

Class.	Materials used in making cement.	Specific gravity.	Per cent passing through sieve.		Time of setting.	Tensile strength in pounds per square inch.												Chemical analysis.					
						Neat.					1 to 3.												
			No. 100.	No. 200.	Initial.	Hard.	1 day.	7 days.	28 days.	6 months.	12 months.	7 days.	28 days.	6 months.	12 months.	SiO <sub>2</sub> .	Al <sub>2</sub> O <sub>3</sub> .	Fe <sub>2</sub> O <sub>3</sub> .	Al <sub>2</sub> O <sub>3</sub> Fe <sub>2</sub> O <sub>3</sub> .	CaO.	MgO.	SO <sub>3</sub> .	
Portland cement.	Limestone and cement rock.....	3.14	96.7	75.2	<i>Min.</i> 155	<i>Min.</i> 392	371	675	750	789	945	239	315	366	442	22.97	7.51	2.50	10.01	62.82	2.58	1.51	
	Limestone and clay or shale.....	3.13	95.0	76.2	172	341	341	696	825	916	919	232	353	401	493	22.18	7.31	3.49	10.80	62.80	1.62	1.39	
	Limestone and granulated basic blast furnace slag.....	3.10	98.5	(a)	260	500	358	636	790	888	916	226	298	382	396	23.62	8.21	2.71	10.92	61.92	1.78	1.62	
	Marl and clay or shale.....	3.11	94.0	79.2	151	357	328	670	772	780	790	260	352	395	395	22.86	6.98	2.68	9.64	68.87	1.99	1.33	
	Average.....	3.12	96.3	76.9	185	398	350	669	784	843	893	247	330	384	409	22.66	7.49	2.85	10.54	62.73	1.99	1.46	
Puzzolan or slag cement.	Slaked lime and granulated basic blast furnace slag.....	2.88	99.4	95.0	145	452	120	452	502	651	(a)	189	260	272	(a)	29.55	12.60	0.80	13.40	50.22	2.23	1.36	
Natural-rock cement.	Argillaceous limestone.....	2.87	92.6	79.9	34	144	129	197	289	404	501	1 to 2.				29.07	10.54	4.08	14.62	39.50	11.77	.....	
												148	226	295	368								

(\*) Omitted for lack of sufficient data.

CEMENT.