CEMENT.

AMERICAN ROCK CEMENT.

By Uriah Cummings.

HYDRAULIC CEMENT.

INCREASED PRODUCT.

There was a slight increase in the production of natural-rock cement during 1894, which is very encouraging considering the prolonged business depression. The increase was confined mostly to Louisville, Ky., Milwaukee, Wis., and the Lehigh Valley district, in Pennsylvania. In most of the other districts there was a slight falling off in the production. The demand was steady throughout the season, and the volume was slightly above the average for the past five years.

PRICE.

There has been an advance of 4.2 cents per barrel over the prices for 1893, and they were a trifle above the average for the past five years.

Prices of natural-rock cement in bulk at mills.

	Cents per barrel.
1890	51.37
1891	47.26
1892	48.61
1893	43.87
1894	48.07

NEW DEVELOPMENTS.

A new plant with a capacity for producing about 250 barrels per day has been erected at Austin, Minn. The cement from this plant was placed on the market during the summer of 1894.

The works of the Howard Hydraulic Cement Company, at Cement, Ga., which were entirely destroyed by fire April 30, 1895, are being rebuilt on a much larger scale, and with all the modern appliances for a successful prosecution of the business.

PRODUCT.

The following table gives the amount and value of the hydraulic cement produced in the United States during 1893 and 1894. The values are based on the price per barrel in bulk at the various factories. The cost of package is always added to the price of the cement by the manufacturer. In the Eastern States the packages are almost wholly of wood, while in the Western States probably over 90 per cent of the cement is sold in jute or paper sacks. For these reasons the values in the table are given exclusive of packages:

Product of hydraulic cement in 1893 and 1894.

States.	1893.			1894.		
	Number of works.	Barrels.	Value.	Number of works.	Barrels.	Value.
Georgia	1	10,273	$7,182	1	9,266	$7,094
Illinois	2	522,972	153,039	2	446,267	133,880
Indiana and Kentucky	13	1,750,350	525,105	13	2,000,000	800,000
Kansas	1	60,000	21,000	1	50,000	25,000
Maryland and West Virginia	5	231,590	125,554	6	279,000	136,250
Minnesota	1	75,000	37,500	1	63,290	31,645
New Mexico	1	1,500	1,125	.....	Idle.	.....
New York:						
Ulster County	17	2,738,884	1,506,386	17	2,659,601	1,595,760
Erie County	4	675,000	327,500	4	578,800	289,400
Onondaga County	8	161,308	57,394	8	187,929	78,303
Schoharie County	1	22,566	14,658	1	20,000	11,000
Ohio	3	68,000	43,550	3	55,023	33,598
Pennsylvania	6	567,110	265,159	5	605,812	269,701
Texas	1	10,000	25,000	1	12,000	18,000
Utah	1	5,000	6,250	.....	Idle.	.....
Virginia	1	17,509	10,707	2	14,500	8,700
Wisconsin	2	494,753	124,638	2	582,000	197,400
Total	68	7,411,815	3,251,757	67	7,563,488	3,635,731

Production of cement of all kinds in the United States since 1880.

Years.	Production.	Value.
	Barrels.	
1880	2,072,943	$1,852,707
1881	2,500,000	2,000,000
1882	3,250,000	3,672,750
1883	4,190,000	4,293,500
1884	4,000,000	3,720,000
1885	4,150,000	3,492,500
1886	4,500,000	3,990,000
1887	6,692,744	5,674,377
1888	6,503,295	5,021,139
1889	7,000,000	5,000,000
1890	8,000,000	6,000,000
1891	8,222,792	6,680,951
1892	8,758,621	7,152,750
1893	8,002,467	6,262,841
1894	8,302,245	5,030,081

That the United States leads the world in the manufacture of natural-rock cement is unquestionably due to the undeniable fact that in no other country is the material to be found which combines within itself so many features of general excellence as to require no artificial manipulation for improving its quality.

The principal source of rock cements in Europe is from the Liassic, or Upper and Lower Blue Lias subdivision of the Jurassic rock formation, the uneven quality of which readily accounts for the recourse to artificial mixtures which has now so universally obtained in that country. The Blue Lias, from which the rock cements are obtained, consists in its lower portion of layers of blue and gray limestones, more or less argillaceous. These layers occur sometimes in even and sometimes in irregular bands, often nodular and interrupted, and they alternate with blue and brown marls, clays, and shales. Nowhere in the Lower Lias is there any marked band of rock which can be traced continuously for any great distance.

The upper portion of the Lower Lias consists of more or less micaceous blue clays, shales, and marls, with occasional septaria nodules and bands of earthy and shelly limestones and sandy layers. There is no rigid plane of demarcation between them and the mass of limestones beneath, while the clays pass upward into the lower beds of the Middle Lias, with no lithological break or divisional line. There is no layer of the rock used for cement purposes which does not vary in its proportion of clay, ofttimes as much as 20 per cent in individual quarries, and we find that while one layer may contain 8 per cent, the one next above or below may contain 50 per cent of clay. Clearly, it is not remarkable that a cement made from such an ill-assorted mass of material should lack in uniformity.

No experienced cement manufacturer in America would undertake to produce a rock cement from such a mixture of clays, shales, marls, nodules, limestones, and cement stones. It is not surprising that artificial mixtures were employed in an endeavor to meet and overcome the dissatisfaction unavoidably growing out of the use of such natural-rock cements. Contrasting these materials with our own massive cement-rock deposits, we find that we have immense beds of cement rock, absolutely free from any extraneous substances, perfectly pure and clean, with layer upon layer extending for thousands of feet without an appreciable variation in the proportions of ingredients.

Cement-rock quarries are worked in this country decade after decade without the necessity of rejecting a pound of the material, and the analyses taken during successive years show no marked changes whatever in the constituent parts. Had England and France possessed such cement-rock formations as are so well distributed throughout this country it is extremely doubtful if the production of artificial cement would have been resorted to. Under such circumstances there would have been no occasion for it.

The magnitude and value of the work done with the natural rock cements of this country is almost beyond comprehension. They have been used in the largest buildings, tunnels, bridges, dams, and aqueducts constructed in America, and a failure has yet to be reported and recorded. More than 100,000,000 barrels have been so used during the past twenty years.

To enumerate the engineering and architectural structures into which this enormous amount of cement has entered would require several volumes, and attention will be called to but a few, which will serve as a fresh reminder that we have here at home hydraulic cement which for cheapness, safety, durability, and positive excellence can not be surpassed by any cement, whether natural or artificial, that is now known to the world.

Among the structures built with native American rock cements we would call attention to the following as being a few of the many in various localities:

Washington, D. C.—State, War and Navy, Department building, Bureau of Engraving and Printing building, Patent Office, National Museum, Pension Office, Library of Congress, Boundary sewer system, etc.

New York.—The old and new Croton aqueducts, High Bridge over the Harlem, foundations and to high-water mark of the Brooklyn Bridge, the entire sewer system of New York and Brooklyn, nine-tenths of the tall modern buildings of lower Broadway, the elevated railroad system, and all of the older New York, the bridges across the Hudson at Poughkeepsie and Albany, the Albany capitol building, all the bridges over the Niagara River, the entire sewer and concrete paving and waterworks systems of Buffalo, and all the important buildings of that city, such as the City and County Hall, the Erie County Savings Bank building, etc.

Cleveland, Ohio.—The great viaduct, the waterworks tunnel under Lake Erie, and the vast sewer system, and nearly every important building in that city.

Chicago, Ill.—The Chicago Board of Trade building, Rialto office building, Pullman works entire, Rookery building, Home Insurance building, Marshall Field wholesale building, the immense Chicago Public Library building, and many other important structures, the several tunnels under the rivers and under Lake Michigan, the elevated railroads, etc.

Farther West.—The great bridges over the Mississippi, Missouri, and Ohio rivers, the public works of Cincinnati, Louisville, St. Louis, St. Paul, Minneapolis, Omaha, Sioux City, and lesser cities, constructed exclusively with American rock cements, together with the almost endless masonry work of the thousands of miles of railroads throughout the entire country, tell the story of the value of our homemade cements, and should stand as an ever-present rebuke to the advocates of imported cements, which, although they may set harder in a short length of time, are no harder after five years, and in process of time the fact will be universally acknowledged that a cement formed by rapid setting is in no manner equal in enduring qualities to one of slower and therefore more perfect setting, such as is found inherent in the natural-rock cements of this country.

PORTLAND CEMENT.

By Spencer B. Newberry.

INCREASED PRODUCT.

The production of Portland cement in the United States during the year 1894 reached a total of 798,757 barrels, as compared with 590,652 barrels in 1893, an increase of 208,105 barrels, or 35 per cent. The increase is not confined to any particular section of the country, but is generally distributed. It results in part from the establishment of new factories, of which 24 were in operation in 1894, as compared with 19 in 1893. The chief increase is, however, seen in the output of the older factories, notably in Lehigh County, Pa. From all sides come reports of the establishment of new works and extension of older plants, so that there is reason to expect a decided further increase in production in 1895. The imports for the year 1894 were 2,638,107 barrels, valued at $3,396,729, a slight decrease from the amount imported in 1893. The following table shows the relative proportion of Portland cement made in this country and imported during the past four years:

Comparison of the domestic production of Portland cement with the imports.

	1891.	1892.	1893.	1894.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Production in the United States	454,813	547,440	590,652	798,757
Imports	2,988,313	2,440,654	2,674,149	2,638,107
Total	3,443,126	2,988,094	3,264,801	3,436,864
Exports		21,536	14,276	9,725
Total consumption	3,443,126	2,966,558	3,250,525	3,427,139
Percentage of total consumption produced in the United States	13.2	18.4	18.2	23.3

From the above table it appears that the importation of cement into this country has remained nearly stationary since 1891, and that the domestic product has gained rapidly in comparison with the imported, until in 1894 nearly one-fourth of the Portland cement used was of American manufacture. There is little doubt that this gain will continue, and that within a very few years practically all the Portland

cement required in this country will be manufactured at home. There is reason to expect a great increase in production during the year 1895, as several new factories are under construction and will be in operation before the close of the season. The low freight rate on cement from Europe to Chicago is no longer offered, and the price of foreign cement shows a decided advance at the beginning of the new year. There appears to be everywhere a decided scarcity of Portland cement, and there is reason to believe that the capacity of American factories will be taxed to its utmost during the next few months. Good American Portland is to be had at 50 cents to $1 per barrel less than the best German, and is being extensively adopted for large Government and private contracts. The battle between natural-rock and Portland cements has been fought out in England and Germany, and has resulted in the complete victory of Portland, and the practical disappearance of the natural-rock cement industry. The result in this country can hardly be so decisive, as most of the natural-rock cements produced here are certainly greatly superior to the Roman cements formerly made in Europe.

The following table shows the product of Portland cement, by States, in 1893 and 1894. In compiling the returns for the past year it was decided to calculate the values in bulk, instead of in barrels, owing to the fact that by far the larger part of the American cement produced is shipped in paper or cloth sacks, and not in barrels:

Product of Portland cement in the United States, 1893 and 1894.

States.	1893.			1894.		
	Number of works.	Product.	Value, including barrels.	Number of works.	Product.	Value, not including barrels.
		Barrels.			*Barrels.*	
California				1	13,300	$43,425
Colorado	1	10,000	$25,000	1	15,000	37,500
Dakota	1	33,739	69,502	1	43,500	80,475
Illinois				1	300	540
Indiana	1	20,000	45,000	1	4,000	7,200
New York	5	137,096	287,725	4	117,275	205,231
New Jersey	1	60,000	96,000	1	72,223	119,168
Ohio	3	36,500	85,500	4	80,653	144,425
Pennsylvania	6	285,317	521,411	7	437,106	718,009
Texas	1	8,000	28,000	1	8,000	24,000
Utah				2	1,400	3,500
Total	19	590,652	1,158,138	24	798,757	1,383,473

MATERIALS.

Portland cement is made from carbonate of lime and clay. These materials may be naturally mixed, as in the case of argillaceous limestones, or entirely separate. In all cases, however, it is necessary to bring the material to correct composition by artificial additions and thorough mixing. In England chalk is the form of carbonate of lime employed. In Germany the chief material is marl (mergel), by which is understood a more or less hard limestone rock containing clay. In

some German factories a pure soft marl (wiesenkalk), or fresh-water chalk, is used, consisting chiefly of carbonate of lime and similar to the marl deposits of this country.

In the United States the materials used are very similar to those of Germany. Most of our clay limestones are highly magnesian, and therefore unsuitable for Portland cement, though they are used on an immense scale for natural-rock cements. At certain localities, however, as in Lehigh County, Pa., at Phillipsburg, N. J., and in the far West, limestones containing sufficient clay and nearly free from magnesia are abundantly found, and in the above localities and from this material most of our Portland cement is made. In the Lehigh County region, the chief seat of the American Portland cement industry, the different strata of rock are carefully selected and mixed in such proportions as to give a material of the right composition.

In central New York, and at a few points in Ohio and Indiana, large deposits of pure white marl are found. This is generally called "shell marl," and is supposed to result from the disintegration of fresh-water shells. In the opinion of the writer, however, these marl beds are generally pulverulent deposits from calcareous springs, and are not formed from shells. At the localities above mentioned this material, artificially mixed with clay, is largely used for the manufacture of Portland cement. Owing to the soft, fine-grained character of the marl the mixing can be much more cheaply done than in the case of limestone, though this advantage is largely compensated for by the necessity of drying out the 40 to 50 per cent of water which the marl generally contains.

As already stated, most American Portland cement is made from argillaceous limestone, as shown by the following table:

Number of cement factories using limestone compared with the users of marl.

Factories producing—	Number.	Quantity.
		Barrels.
Limestone	17	611,829
Marl	7	186,928
Total	24	798,757

The first group includes 6 factories in the Lehigh County region, in Pennsylvania, producing over 400,000 barrels; one at Phillipsburg, N. J.; and 10 at other points. The second group, using marl, includes four factories in New York, two in Ohio, and one in Indiana.

PROCESSES.

There are four distinct forms of kiln used in burning Portland cement. These are (1) intermittent or dome kiln, (2) continuous kiln, of the Dietzsch or Shöfer type, (3) Hoffmann ring furnace, (4) rotary furnace. In the old-fashioned intermittent kiln the bricks of cement mixture are charged into the kiln with coke in alternate layers, and the whole allowed to burn out and cool down before emptying. The Dietzsch or

Shöfer continuous kiln is continuously charged with bricks of cement mixture and soft coal, and the burned clinker periodically withdrawn at the bottom. It presents the great advantage of cheaper fuel and economy of labor. The Hoffmann ring furnace consists of a number of chambers arranged around a central stack. These are filled with bricks of cement mixture and the fuel introduced through the openings in the top. This form of kiln is economical of fuel, but requires more labor than the other types of kiln. The Hoffmann ring furnace is used in this country to some extent in burning brick, sewer pipe, and lime, but not, so far as the writer can learn, in the manufacture of cement. The rotary furnace has been fully described in previous reports. Crude or fuel oil is used as a source of heat at all points where this kiln is employed.

In the United States most of the Portland cement produced is burned in the old-fashioned intermittent kilns. The Dietzsch kiln is used at Harper and Middle Branch, Ohio. The Shöfer kiln is to be used at new works now beginning operations at Glens Falls, N. Y. The rotary furnace is in operation at Colton, Cal.; Phillipsburg, N. J.; Coplay, Pa., and Sandusky Ohio. The following table shows the number of barrels of cement made during the past two years in vertical kilns (continuous and intermittent) and the rotary furnace:

Amount of Portland cement made in kilns of various kinds.

	1893.	1894.
	Barrels.	*Barrels.*
Rotary furnace	149,000	242,176
Vertical kilns (continuous and intermittent)	441,653	556,581
Total	590,653	798,757

It thus appears that the output of rotary furnaces has increased much more rapidly than that of vertical kilns. The recent rapid advance in the price of crude oil is a great obstacle to the use of the rotary furnace. Attempts are being made to substitute producer gas for crude oil in burning cement. There is no reason why this should not be successfully done, and the change will greatly reduce the cost of burning cement at all points where the rotary process is used.

For grinding the finished product the Griffin steel mill is used at the larger factories. Some of the older works still use buhrstones. The Griffin mill consists of a steel ring, against the inside surface of which a heavy steel roll revolving on a vertical shaft presses by centrifugal force. The mill is provided with screens which allow powder of the requisite fineness to pass through, while the coarser particles drop back into the mill. This mill is an American invention, and is rapidly finding its way into the leading cement works of Germany.

GENERAL NOTES ON THE PORTLAND CEMENT INDUSTRY.

California.—In 1894 a new factory began operations at Colton. The materials used are a white "coralline" limestone, stated to contain 99.30 per cent carbonate of lime and 0.38 per cent silica and graphite. The clay used contains 47.5 per cent silica, 32.6 per cent alumina and iron oxide, 10.4 per cent lime, and 1.02 per cent magnesia. The materials are mixed in the dry state and burned in a rotary furnace, using crude oil as fuel. The present capacity of the plant is stated to be 180 barrels per day. Enlargements are in progress which will give double this capacity by August, 1895.

New York.—The works of the Warner's Portland Cement Company were not in operation during 1894. New works are in process of erection at Cassadaga Lake, Chautauqua County. The bottom and shores of this lake are composed of white marl, which will be taken out by means of a dredge. At Glens Falls, N. Y., works were erected in 1893 for the manufacture of Portland cement, and began operations in April, 1894. The enterprise is under the direction of Capt. W. W. Maclay, formerly chief of the department of docks, New York City, and well known as an expert on cement testing. At these works limestone of the Devonian formation is used. This contains 93 per cent carbonate of lime and 2 per cent insoluble matter. The clay employed contains 59 per cent silica, 23 per cent alumina, and 6 per cent iron oxide. The dry process is used in mixing, and the burning is done partly in intermittent kilns and partly in continuous kilns of the Shöfer type. The total capacity of the works is stated to be about 350 barrels per day.

New Jersey.—The works of Thos. D. Whitaker at Phillipsburg were partly destroyed by fire January 20, 1894, and were shut down in consequence until May 15. Another factory is being erected at Phillipsburg by the Vulcanite Cement Company.

IMPORTS.

The following table shows the imports of all classes of cement into the United States during the fiscal years ending June 30, 1893 and 1894, arranged by ports.

Imports of cement, by ports, during the fiscal years ending June 30, 1893 and 1894.

Ports.	1893.		1894.	
	Pounds.	Value.	Pounds.	Value.
Atlantic coast.				
Aroostook, Me	8	$2	163,000	$853
Baltimore, Md	108,479,638	359,144	77,968,821	249,039
Bath, Me			8,400	54
Boston and Charlestown, Mass	61,346,305	208,783	62,072,160	198,653
Charleston, S. C	2,482,400	8,709	6,224,911	21,956
Georgetown, D. C	4,000	10	165,345	655
Newport News, Va			11,904,000	35,920
New York, N. Y	504,135,906	1,690,622	384,406,068	1,251,090
Passamaquoddy, Me	600	4		
Philadelphia, Pa	129,883,778	412,140	111,829,516	348,662
Portland and Falmouth, Me			1,699,608	5,246
Richmond, Va			200,000	613
Savannah, Ga	6,350,902	19,031	9,881,156	27,008
Wilmington, N. C	222,224	800		
Total	812,905,761	2,699,245	666,522,985	2,139,749
Gulf coast.				
Galveston, Tex	27,563,767	93,322	19,207,393	58,681
New Orleans, La	112,445,409	377,288	83,794,052	273,570
Pensacola, Fla	806,840	3,261	1,315,559	4,005
Tampa, Fla	936,000	3,225		
Total	141,752,016	477,096	104,317,004	336,256
Pacific coast.				
Los Angeles, Cal	11,027,183	36,068	6,658,448	21,637
Oregon, Oregon			399,980	1,277
Puget Sound, Wash	24,141,906	82,079	21,706,002	66,665
San Diego, Cal	22,744,180	79,300	14,761,600	48,802
San Francisco, Cal	82,643,856	279,478	135,889,312	433,364
Willamette, Oregon	14,652,325	49,706	47,560,684	155,223
Total	155,209,450	526,631	226,976,026	726,967
Lake.				
Buffalo Creek, N. Y	115	40		
Cape Vincent, N. Y	50,900	164	76,450	245
Champlain, N. Y	98,900	387		
Chicago, Ill	1,374,262	4,811	998,026	3,289
Cuyahoga, Ohio	40,000	136	194,000	808
Detroit, Mich	11,000	61	313,300	1,420
Huron, Mich			2,700	20
Miami, Ohio			412,500	1,750
Oswegatchie, N. Y	815,285	2,476	3,605	27
Oswego, N. Y	2,220	12	74,000	400
Total	2,392,682	8,087	2,074,581	7,959
Interior.				
Vermont	5,600	26	5,600	26
Cincinnati, Ohio	99,207	393		
Indianapolis, Ind			80,000	255
Kansas City, Mo	80,000	257	80,000	260
Louisville, Ky	266,138	1,008	200,000	618
St. Louis, Mo	12,223,701	47,701	14,877,677	52,997
Total	12,654,646	49,385	15,243,277	54,156
Grand total	1,124,914,555	3,760,444	1,015,133,873	3,265,087