CEMENT

By Hendrik G. van Oss

Cement is the binding agent in concrete and mortar and its production and consumption are fundamental economic indicators for a country's construction industry. Total U.S. production of portland and masonry cement increased in 1997 by 4.2% to a new record level of 82.6 million (metric) tons; 96% of this was portland cement.*(See tables 1-3.)* Clinker production *(see table 4)* also set a new record of72.7 million tons. Clinker and cement output were at or near full practical capacity levels. The United States ranked third in the world in terms of cement production; world output *(see table 22)* was about 1.5 billion tons.

Calculated U.S. apparent consumption of cement increased 6.3% to 96.0 million tons in 1997, and consumption as measured by sales to final customers increased 5.8% to about 96.5 million tons.The substantial excess demand was met by increased imports.Exports remained a very small component of total U.S. cement trade and declined slightly during the year. Cement prices increased, although to a lesser degree than in 1996.The total ex-plant value reported for annual cement shipments from mills and terminals to final customers increased 11% to about $6.6 billion.The same component unit values applied to reported monthly sales to final customers—a larger tonnage—yield a total value for 1997 that increased 9% to about $7.1 billion. By using typical cement-in-concrete mix ratios, the value (delivered) of concrete(excluding mortar) in the United States in 1997 was estimated to be at least $27 billion.

Hydraulic cements are those that will set and harden under water and are overwhelmingly the dominant form of cement produced in the United States and the rest of the world. In turn, the production of hydraulic cements is dominated by that of portland (broadly defined) and related masonry cement. Except for certain trade and international production data, this report is concerned only with portland and masonry cements. Thus excluded are certain other hydraulic varieties, such as pure pozzolan and aluminous cements; these cumulatively make up only a small fraction of the U.S. cement market.

The term "portland cement" refers to the finished product which, in the strictest sense, is a finely interground mixture of portland cement clinker and 3% to 5% gypsum. Thus, portland cement can be produced either by integrated cement plants, which manufacture clinker and grind it to make cement, or by stand-alone facilities that grind clinker obtained elsewhere. Clinker comprises mostly calcium silicates and is made by controlled high-temperature burning in a kiln of a measured blend of calcareous rocks (usually limestone) and lesser quantities of siliceous, aluminous, and ferrous materials as needed. The kiln feed blend (also called raw meal or raw mix) is adjusted depending on the chemical composition of the raw materials and the type of portland cement desired. In the United States, five basic types (Types I through V) of portland cement are recognized, denoting such properties as high sulfate resistance and high early strength. Other designations may be used in other countries for similar portland cements. Portland cement is almost always gray, but a more valuable version—white cement—can be obtained if care is taken to burn only iron-free raw materials.

Although technically restricted to Types I through V, it is common U.S. industry practice, and that of this report, to include as portland cement almost all nonmasonry varieties of cement that contain portland cement clinker, notably the so-called blended cements. Blended cements are interground mixtures of (finished) portland cement (or ground clinker plus gypsum) and pozzolans. The proportion of pozzolans is quite variable, but is commonly in the range of 15% to 50% by weight. Pozzolans are siliceous materials, such as certain rocks (mainly tuffs, diatomaceous earths, and burned clays or shales) and industrial byproducts (mainly granulated blast furnace slag, fly ash, and silica fume), that exhibit hydraulic cementitious properties when finely ground and interacted with free lime and water. Blended cements are of similar strength as (straight) portland cements and commonly offer improved resistance to certain types of chemical attack and reduced environmental impact of manufacture.

On the basis of available data, blended cements appear to be only a small component of the U.S. cement market at present, in contrast to their greater popularity in many countries overseas. Blended cements can be purchased, but some concrete manufacturers do their own mixing of pozzolans with purchased (straight) portland cement. In terms of the resulting cement paste, the distinction between adding pozzolans to the concrete mix and having them introduced to the concrete within a purchased blended cement would appear to be more semantic than real.

Concrete is a controlled mixture of cement, fine and coarse aggregates, and water that, through complex hydration reactions, hardens into a rocklike mass of specifiable properties. Apart from doing their own mixing of pozzolans into the mix, there is substantial consumption by concrete manufacturers of nonpozzolanic, or slightly pozzolanic, varieties of slag, fly ash, and the like, for use as aggregates. Concrete manufacturers are not surveyed and hence the true extent of consumption of blended cements by the concrete industry in the United States is not known. Further, there is some consumption of "pure" pozzolan cements that do not involve the addition of portland cement. In such cases, the pozzolan activator generally is added lime. Data from pozzolans suppliers tend to lump together sales to the cement and concrete manufacturers, and commonly do not differentiate sales of pozzolans from similar, but nonreactive, material used as aggregates. Accordingly, the data in this report, which are supplied by the cement manufacturers as to consumption of pozzolans and subsequent sales of blended cement, under represent the true market for these materials,

likely by as much as a factor of two or three.

As with portland cement, the term "masonry cement" is used broadly in this report and includes portland lime and plastic (portland cement mixed with plasticizing agents) cements. However, this combination is not the universal practice of the industry and it remains possible, particularly with monthly sales data *(see tables 8 and 9)*, that some portland lime and plastic cement data for some regions have been reported within the portland cement designation. Overall, the tonnages misassigned likely are small. Masonry-type cements are used in mortar, which is a mixture of cement, fine aggregate, and water used to bind together building blocks, such as bricks and stones. Masonry cements can be made either from portland cement or directly from clinker. The manufacture of masonry cement involves incorporating a high percentage (e.g., 50%) of admixtures—commonly ground limestone or lime. In some cases, particularly with portland lime cements, the purchased components can be mixed at the construction site. Accordingly, the data in this report, which are for masonry cement produced and sold by cement manufacturers only, under report the true production and consumption of this material, particularly for some regions of the country.

The bulk of this report, particularly tables 1 through 7 and 10 through 15, incorporates data compiled from U.S. Geological Survey (USGS)[1] annual surveys of individual cement and clinker manufacturing plants and certain terminals and importers. In 1997, responses were received from 135 of the 136 facilities canvassed, including all producers; these facilities accounted for 100% of total U.S. cement production and more than 99% of shipments. In 1996, responses were received from 124 of the 134 facilities canvassed, recording more than 99% of production and shipments. Tables 8 and 9, in contrast, are based on monthly shipments surveys of the cement-producing companies and importers, and for these, the response rate was 100% for both years.

For cases where annual questionnaires were returned incompletely or improperly filled out, followup inquiries were made, after which estimates were made and incorporated for any remaining missing data. Estimates for most information categories constituted only very small percentages of the aggregated totals and, thus, the introduced estimation errors are considered to be insignificant. Two important exceptions are the data for values *(see tables 1 and 11-13)*, where a significant number of facilities routinely omit or incorrectly report the information, and the data for portland cement shipments by customer (user) type *(see table 14)*, where the cement producers readily admit to having incomplete knowledge.

As in previous years, there is a significant tonnage discrepancy between the annual shipments totals in tables 1 and 10-15 for portland cement and the larger (monthly based) totals shown in tables 8 and 9.The difference for masonry cement is small. Because they are more complete, the data in tables 8 and 9 are the preferred measure of true U.S. consumption (see Consumption section); these data (actually the component monthly data) are used by U.S. cement companies to estimate their market shares and to perform many other economic analyses. Integration of the data from tables 8 and 9 data with those from the other tables has not been done to avoid creating additional internal inconsistencies.

There were two significant changes in cement company ownership in the United States during the year and one other that was announced, but which would take effect early in 1998.In April 1997, Blue Circle Industries of the United Kingdom completed the purchase, announced in January, of St. Marys Cement Corp. of Canada (Blue Circle, 1997).Blue Circle, one of the largest cement producers in the United States, gained through this purchase St. Marys' large grinding plant in Detroit, MI, several U.S. distribution terminals, and two integrated plants and associated terminals in Canada. Early in the year, Australian company Adelaide Brighton Ltd. sold its 50% ownership in Hawaiian Cement Co. to the co-owner, Knife River Corp. of North Dakota (International Cement Review, 1997a).In September, Texas-based producer TXI Inc. reached an agreement to purchase Riverside Cement Co., a major California producer, from the Korean company Ssangyong Cement Industrial Co., Ltd (International Cement Review, 1997c).The purchase was to take effect January 1, 1998.The purchases of Hawaiian Cement and Riverside Cement were departures from the trend, begun in the 1980's, of foreign companies buying U.S. cement plants.

State data in a number of tables are presented within State groupings or districts, generally corresponding to Census Districts or subsets thereof, where required to protect proprietary information. Certain major cement-producing States have been subdivided along county lines to provide additional market information.[2]

Tables 16 through 21 show nonproprietary trade data from the U.S. Bureau of the Census in lieu of the proprietary data collected through the USGS monthly questionnaires. World production data shown in table 22 were derived by USGS country specialists, from a variety of sources. These production data are for hydraulic cement (all types) and the entries for a few countries may include clinker exports.

[1]Data prior to 1995 were collected by the former U.S. Bureau of Mines.

[2]State subdivisions are as follows:

California, northern.—Alpine, Fresno, Kings, Madera, Mariposa, Monterey, Tulare, and Tuolumne Counties, and all those further north.

California, southern.—Inyo, Kern, Mono, and San Luis Obispo Counties, and all those further south.

Chicago, metropolitan.—Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will Counties in Illinois.

Illinois.—All counties other than those included within Metropolitan Chicago.

New York, eastern.—Delaware, Franklin, Hamilton, Herkimer, and Otsego Counties, and all those further east and south, excepting those within Metropolitan New York.

New York, western.—Broome, Chenango, Lewis, Madison, Oneida, and St. Lawrence Counties, and all those further west.

New York, metropolitan.—The five counties of New York City (Bronx, Kings, New York, Queens, and Richmond) plus Nassau, Rockland, Suffolk, and Westchester Counties.

Pennsylvania, eastern.—Adams, Cumberland, Juniata, Lycoming, Mifflin, Perry, Tioga, Union County, and all those further east.

Pennsylvania, western.—Centre, Clinton, Franklin, Huntingdon, and Potter Counties, and all those further west.

Texas, northern.—Angelina, Bell, Concho, Crane, Falls, Houston, Irion, Lampasas, Leon, Limestone, McCulloch, Reeves, Reagan, Sabine, San Augustine, San Saba, Tom Green, Trinity, Upton, and Ward Counties, and all those further north.

Texas, southern.—Burnet, Crockett, Jasper, Jeff Davis, Llano, Madison, Mason, Menard, Milam, Newton, Pecos, Polk, Robertson, San Jacinto, Schleicher, Tyler, Walker, and Williamson Counties, and all those further south.

Legislation and Government Programs

Economic Issues.—The cement industry is affected by a range of Government economic policies. Of particular interest are Government spending programs, or proposals therefore, related to public construction, and to any and all other policies—especially those concerning interest rates—that would affect private construction programs.

Probably the most important Government actions in recent years with respect to the cement industry concern imports. A number of factors led to large quantities of inexpensive cement being imported into the United States in the 1980's. These imports undercut prices at a time when the domestic cement industry was simultaneously having to contend with rapidly rising production costs and reduced overall demand. During this time, a number of plants closed, and many others were purchased by foreign companies. A number of cement companies complained that Japan, Mexico, and Venezuela were dumping cement and/or clinker onto the U.S. market. The U.S. Department of Commerce determined that the pricing was unfair and this led to the imposition of antidumping tariffs on imports from Japan and Mexico and to a voluntary restraint agreement with Venezuela. The tariffs dramatically reduced the imports of cement and clinker from Japan from 1.9 million tons in 1990 to 0.3 million tons in 1991, and thence to negligible levels from 1993 onwards. Anticipation and eventual imposition of tariffs on Mexican imports similarly led to a decline from a peak of 4.5 million tons in 1988 to 0.6 million tons in 1994.The main Mexican company involved has repeatedly appealed the tariffs, and imports from Mexico increased in 1995 and reached almost 1.3 million tons in 1996.The appeals to date have all been turned down, and the tariffs reaffirmed. In April 1997,the U.S. Department of Commerce released its determinations for the two review periods covering August 1993 through July 1994 and August 1994 through July 1995.The tariffs for these periods were set at 109.43% and 103.82%, respectively (Southern Tier Cement Committee, 1997).Imports from Mexico declined to about 1 million tons in 1997.Although cement and clinker imports from Venezuela fell dramatically from 1990 to 1992, they have grown steadily since, reaching almost 2 million tons in 1997. But, overall, rising imports of cement and clinker since the early 1990's have served to meet excess demand rather than undercut domestic production. Based on the data in tables 11, 12, and 18; the imports may have constrained, but appear not to have led to a lowering of, regional cement prices.

Because of high transportation costs, cement markets tend to be fairly local, especially where access must be by truck. Competition among cement plants serving a market tends to be keen, and this, coupled with the fact that most plants have broadly similar production technologies and costs, have tended to constrain cement price variations within a market. Uniform prices within cement markets have led to periodic Government antitrust investigations of the industry, to date without findings against the cement companies. No such investigations were reported ongoing in 1997.

Environmental Issues.—Cement production involves mining and manufacturing activities. About 120 million to 135 million tons per year of nonfuel raw materials are mined *(see table 5)* for cement manufacture, generally from open pit operations. Environmental issues affecting this activity are common to most surface mines and include problems with dust, increased sediment loads to local streams, chemical changes to local water supplies, etc. Of greater concern are the environmental impacts of the cement manufacturing process, most of which stem from the manufacture of clinker. Clinker kilns burn large quantities (12 to 13 million tons per year *(see table 6*) of fossil and/or other organic fuels to thermochemically break down (calcine) calcareous and other rocks to instigate clinker-mineral-forming chemical reactions.

In the debate over climatic change, the impact of so-called greenhouse gases on atmospheric warming is a major issue. The most common greenhouse gas is carbon dioxide (CO_2), and both fuel combustion and carbonate (limestone) calcination in the clinker kilns generate large quantities of this gas. As explained more thoroughly in the previous edition of this report (van Oss, 1996), precise determinations of the CO_2 emissions of the U.S. cement industry are not available, but the amount for the country may be estimated to within 5% to 10% based on various assumptions of the composition of the raw materials and fuels consumed or that of the clinker produced. The clinker manufacturing technology also plays a role—wet kilns consume more fuel on a unit (of clinker) output basis than do dry kilns. On average, it may be estimated that the calcination component of clinker production releases between 0.50 and 0.57 ton of CO_2 per ton of clinker produced and the fuel consumption component about 0.48 to 0.50 ton per ton of clinker, for a total release of about 1 ton of CO_2 per ton of clinker. This translates to about 0.95 ton of CO_2 per ton of "straight" portland cement. It is, however, better to calculate CO_2 based on the production of clinker, rather than of portland cement, because the cement tonnage may include material made from the grinding of imported clinker (in which case the CO_2 was generated elsewhere).Also, finished cement may include pozzolan, or even inert, components which replace an equivalent mass of clinker in the finished product, although this has yet to become a common practice for portland cement in the United States. Of course, most of the major synthetic pozzolans are themselves produced by CO_2-generating industries (e.g., blast furnace slag is a byproduct of the iron smelting industry, and fly ash is a byproduct of coal-fired powerplants), but the emissions are credited to those industries. Using the clinker data in table 4, it is estimated that the U.S. cement industry released about 74 million tons of CO_2 in 1997.In addition, U.S. cement plants consumed electricity *(see table 7)* equivalent to about 7 million tons ofCO_2, but this generally would be assigned to the electrical power industry.

The concern of the cement industry with CO_2 emissions stems mainly from the possibility that the Government will seek to reduce emissions through the imposition of carbon taxes or emissions quotas. At the United Nations Framework Convention on Climate Change, held in December in Kyoto, Japan, measures were agreed to that would have so-called developed countries reduce their emissions of greenhouse gases to levels below those in 1990; for the United States, the "Kyoto Protocol" reduction requirement was 7% below levels in 1990, to be achieved by the year 2012.With current U.S. emissions of greenhouse gases

substantially higher than the 1990 levels, the Kyoto targeted reduction for the United States implies an actual reduction well in excess of 7%.At least initially, so-called developing countries would be encouraged, but not required, to reduce their emissions of greenhouse gases.

It is not clear how a large reduction in U.S. CO_2 emissions could be achieved without substantial increases in energy and production costs throughout the economy, or without having domestic manufacturers facing increased competition from imports originating in countries not encumbered by the Kyoto accords. Given the voiced concerns over the economic consequences of the accords, the U.S. Congress passed resolutions (House Resolution 4761 and Senate Resolution 98) requesting that the President not sign the Kyoto Protocol, nor submit it to Congress for ratification until it is amended to include the developing countries. However, even lacking ratification, it was expected that the Government would encourage the industry to find ways to begin to reduce CO_2 and other greenhouse gas emissions.

For the U.S. cement industry, meeting the Kyoto levels of reduction in CO_2 emissions could require the shutdown of a number of older plants (especially those operating less energy efficient wet kilns).However, a much larger contribution to reduction of CO_2 emissions would be achievable through a drastic change in the formulation of finished portland cement, specifically, a major reduction in the average clinker component (currently about 95%) of cement produced at integrated plants. In other words, the U.S. cement industry could change from a product line dominated by "straight" portland cement to one dominated by blended cements. Although blended cements can have satisfactory performance characteristics, a radical shift to their use would require changes in many building codes, namely changing the cement specifications from a compositional basis to a performance basis. Further, a major shift to blended cements could lead to regional shortages of suitable pozzolans. Barring a commensurate increase in overall cement consumption, a major shift to blended cements would necessarily leave some kiln capacity idle or underutilized.

Another major waste product of clinker manufacturing is cement kiln dust (CKD), made up of fine particles of clinker, incompletely reacted raw materials and solid fuels, and material eroded from the kiln's refractory brick lining. Almost all CKD is captured by either electrostatic precipitation or baghouse filtration. On average, about 70% of CKD is recycled to the kilns as part of the raw meal, and another 5% or so is used for other purposes, commonly as a soil conditioner (liming agent) or for road bases. The remaining CKD, amounting to about 3 million tons annually, is removed to landfills—this is required for CKD containing contaminants levels (e.g., of excessive alkalis, chromium, vanadium, and toxic organic compounds) that preclude recycling.

Government proposals to reduce cement industry emissions of nitrogen oxides (NO_x) and sulfur oxides (SO_x), dioxins and furans, and other contaminants, are of concern to the industry, particularly to the degree that changing emission limits necessitates changes in testing procedures, equipment, and operating practices. These limits also affect the ability of plants to utilize waste fuels cheaply because the emissions are largely a function of fuel type and combustion conditions within the kiln. The Government was moving towards regulating kiln emissions within the regulatory Maximum Achievable Control Technology (MACT) framework, under which the standards adopted for each contaminant would be the average emissions levels of the 12% least polluting plants. The U.S. Environmental Protection Agency issued preliminary MACT standards in 1996, but had not issued final standards as of yearend 1997.

Production

Cement was produced in 1997 at 118 plants, in 37 States and in Puerto Rico, by 42 companies (other company totals are possible depending on ownership breakdowns), of which 1 was State-owned. Production and related data are shown in tables 2 through 6.About 63% of U.S. cement production and capacity was foreign-owned.

Florida Rock Industries broke ground early in the year for a new integrated 0.75-million-ton-per-year cement plant at Newberry, FL—the first new greenfields plant in the United States in a decade. The plant was expected to come on-line around midyear 1999 (World Cement, 1997a).

A number of companies were engaged in, or planning, projects to upgrade their plants to one degree or another to reduce operating costs and/or to increase capacity. Among the major projects, Ash Grove Cement Co. was upgrading its Durkee, OR, plant to increase capacity by 80% to 0.9 million tons per year; the work was expected to be completed early in 1998 (International Cement Review, 1998a).Blue Circle America Inc. continued its work, begun in 1996, to expand the capacity of its Harleyville, SC, plant by 0.3 million tons per year. A new crusher was installed in the quarry, and the kiln's preheater capacity was enlarged. A new precalciner and a new roller mill were to be installed in early 1998 (U.S. Geological Survey, 1997a).Holnam, Inc. completed its conversion from wet to dry kiln technology at its Devils Slide facility at Morgan, UT. The new 0.7-million-ton-per-year kiln was fired up in November and replaced two wet lines having one-half as much (total) capacity. The new kiln burns an interesting mix of fuels, namely coal, natural gas, waste tires, and waste material from the manufacture of disposable diapers (U.S. Geological Survey, 1997b; International Cement Review, 1998b).Lafarge Corp. was installing a new kiln line at its Sugar Creek, MO, plant that will raise the output capacity by 70% to 0.9 million tons per year and is expected to be in production in the year 2000 (World Cement, 1997b).The Union Bridge, MD, plant of Lehigh Portland Cement Co. was being upgraded to a capacity of 1.5 million tons per year, a 50% increase (World Cement, 1997b).Lone Star Industries Inc. expanded the capacity of its granulated blast furnace slag grinding plant in New Orleans, LA, and was planning to mix some blended cements there in addition to its primary ground slag product (Rock Products, 1998a).Tarmac America Inc. announced that its was going to convert from wet to dry technology at its Pennsuco Cement subsidiary company's Miami, FL, plant, increasing the plant's capacity thereby by one-third to 1.2 million tons per year of cement plus 0.2 million tons per year of ground slag (Tarmac America Inc., 1997).In June, Southdown, Inc. started up its new finish mill (constructed in 1996) at its Fairborn, OH, plant, part of a project to expand capacity by 0.1 million tons per year (U.S. Geological Survey, 1997c).At its

Victorville, CA, plant, Southdown completed its 0.3-million-ton-per-year kiln upgrade project in August (U.S. Geological Survey, 1997d) and was planning to add a further 0.3 million tons per year to the pyroprocessing capacity of the plant in 1999 (International Cement Review, 1997b).

There were no permanent plant closures announced during the year.

Portland Cement.—In the United States and Puerto Rico, portland cement was manufactured at 118 plants, including 8 dedicated grinding facilities for clinker (some of these also ground slag).The regional distribution of these plants, cement production and capacities, and yearend cement stockpiles, are given in table 2.

Portland cement production rose by 4.2% in 1997 to a new record of almost 79 million tons. As shown in table 2, increases were noted in most States. The top five portland cement producer States continued to be, in descending order, California, Texas, Pennsylvania, Michigan, and Missouri. Nationwide, calculated cement (grinding) capacity utilization was at very high levels—almost 85% overall. This statistic, however, is misleading in that it compares the reported grinding capacity with (only) the portland cement output. In reality, the masonry cement tonnage *(see table 3)* should be incorporated for most plants, which would increase the overall grinding capacity utilization for the country to almost 89%.Given the fact that the reported capacities are supposed to exclude all but routine downtime, the utilization levels shown are likely at or very close to practical limits. Although a number of plants had capacity improvement projects underway, some of the 1996-97 district changes shown could simply reflect a difference in reporting personnel or in their data rounding from one year to the next. Reported grinding capacities are somewhat subjective and, thus, the minor increase shown for the U.S. total capacity and capacity utilization in 1997 may not be statistically significant. As in previous years, the grinding capacity shown substantially exceeds the clinker capacity given in table 4.The main reasons for this are that the grinding capacity includes that of dedicated grinding plants (but not all districts have such plants); the annual grinding capacities for plants are reported directly to the USGS, whereas those for clinker are calculated; some plants have extra capacity for grinding purchased clinker and/or inert or pozzolan extenders; and it is cheaper to construct grinding capacity than clinker capacity.

Yearend portland cement stockpiles were about 0.25 million tons higher than those in 1996.It is difficult to evaluate changes in yearend national inventories—particularly such small ones—for a number of reasons. An increase in stocks could represent buildup of material ahead of shutting down the kiln(s) for routine maintenance or other work to allow for continued normal sales deliveries of cement. Such buildups would normally follow a buildup of clinker stocks, for which data are unavailable. The timing of kiln shutdowns for maintenance is not consistent for a given plant or among plants. Buildups could represent the coming on-stream, or the reaching of full production levels, of new or upgraded production capacity. Changes in stockpiles could reflect changes in sales volumes towards yearend. They can reflect mass changes associated with conversion to other types of cement, such as a "straight" portland cement being converted to a blended or a masonry cement. Finally, stockpiles appear to be prone to accounting inconsistencies, as evidenced by the fact that yearend stocks for a given facility reported in one year commonly are significantly different from the beginning year stockpiles reported in the subsequent year's survey.

Data are not collected on the production of specific types ofportland cement (e.g., Type I vs. Type III), but it is likely that production by type, at least of the major varieties, was proportional to the reported shipments by type, which are shown in table 15.Assuming this to be true, it is evident that gray portland cement Types I and II again accounted for about 90% of total output.

Portland cement producers in the United States ranged from companies having a single plant of less than 0.5% of total U.S. capacity to large multiplant corporations. The largest of these had 13% of total U.S. cement production capacity. The top 10 companies were, in descending order of production, Holnam, Inc.; Lafarge Corp.; Southdown, Inc.; Blue Circle Inc. (including St. Marys Cement Co.); Essroc Materials, Inc. (including San Juan Cement); Ash Grove Cement Co.; Lone Star Industries, Inc.; Medusa Corp.; California Portland Cement Co.; and Lehigh Portland Cement Co. However, some individual company performances and their rankings are ownership-dependent; thus if Lehigh Portland Cement is combined with CBR Cement Corp. (CBR), based on their common major parent, Heidelberger Zement AG of Germany, Lehigh would rank 6th instead of 10th.Depending on the ownership combinations chosen, the top 10 companies in 1997, combined, accounted for 61% to 65% of U.S. portland cement production and capacity.

Masonry Cement.—Reported production of masonry cement (including portland lime and plastic cements), as shown in table 3, increased 4.8% to about 3.6 million tons in 1997, which was 4.4% of total U.S. cement output. Production was very close to consumption (slightly in excess of shipments shown in table 8 (preferred); slightly less than shipments shown in table 12).The significant increase shown in stockpiles may be largely due to imports but, because the trade data in tables 17 through 21 do not split out masonry cement, the slender evidence for this is the modest increase in 1997 in the amount of masonry shipments to final customers reported as being of foreign origin in table 8.However, this amount does not represent total imports.

Masonry cement was produced in 1997 by 35 companies at 83 plants, all but 2 of which also produced portland cement. Almost 94% of total masonry cement was produced directly from clinker in 1997, as opposed to being produced from portland cement. It is unclear if this proportion, up from the 89% in 1996, reflects increased activity by dedicated clinker grinding plants, or a change in the relative amounts produced of (true) masonry, portland lime, and plastic cements countrywide.

Clinker.—The production of clinker increased 3.3% in 1997 to a new record of72.7 million tons; output increased in all but a few districts. Including the facilities in Puerto Rico, clinker was produced by 110 integrated cement plants, operating 200 kilns. Two-thirds of the plants used dry-process kiln technology.

Table 4 provides district-level information on clinker production and capacity. Capacity utilization for the country was about 89%, and no district had a utilization level of less than 84%.As with clinker (cement) grinding capacities discussed earlier, these levels of performance represent full, or near full

practical, output levels, as was the case in 1996.

It is important to note that the clinker capacity and capacity utilization data for 1997 show significant differences from those reported for 1996 (van Oss, 1996, table 4).Calculated annual capacity was about 81.3 million tons in 1997 and was shown as 74.2 million tons in 1996.Capacity utilization in 1996 was shown as 95%.Although it is likely that ongoing capacity expansion programs resulted in some actual capacity increases, the overall increase in 1997 almost certainly was not the 10% shown, nor is it likely that capacity utilization rates decreased (significantly or at all) in 1997.The problem lies within the calculation of annual capacity.

As the term is used in this report, annual clinker capacity is calculated from a reported 24-hour daily capacity for each kiln, times a period of 365 days minus "scheduled" downtime. Idle kilns that cannot be restarted, for whatever reason, in less than 6 months are not counted (one such kiln that was inadvertently retained in 1996 for eastern Pennsylvania was removed for the 1997 table).Scheduled downtime is supposed to mean only that for routine maintenance (mainly rebricking of the kiln(s); other maintenance, to the degree possible, would be scheduled concurrently).Typically, routine maintenance takes 15 to 30 days each year. Scheduled maintenance is not supposed to include plant upgrades, except to the degree that this work is carried out simultaneously with the routine kiln shutdowns. All downtime beyond that needed for routine maintenance is supposed to be reported as "unscheduled" downtime, which plays no role in the annual capacity calculation. However, many plants misreport downtime for plant upgrades under the "scheduled" category (because the work has been planned), even where that work extends beyond the routine maintenance period(s).The result of this extra scheduled downtime is a calculated annual capacity that is too low and a capacity utilization rate that is too high—commonly in excess of 95% or even 100%.For annual capacity as defined above, such a performance generally would be possible only for short periods, under circumstances of no unexpected mechanical problems and less time than normal taken for routine maintenance work. It is doubtful that such a performance for a cement plant or other large industrial facility, much less several in an entire District, could be maintained over the span of a year.

Because of seemingly excessive annual capacity utilization rates in recent years preceding 1997, great effort was made, for the 1997 survey,to recontact all of the plants that reported seemingly high (in excess of 30 days) totals for scheduled downtime to see if, in fact, the plants' reporting was in error. In virtually every case, the plants so contacted provided downward revisions of the scheduled downtime (but not the total downtime).These revisions increased the calculated annual capacities and reduced the utilization rates relative to the original data, and relative to the probably erroneous reporting of previous years. It was not practicable to similarly obtain corrections for the 1996 and earlier data. However, if the 1997 average of 26 days of downtime (for routine maintenance) is applied to the data for 1996 (instead of the 36 days actually reported), the 1996 annual capacity climbs to 77.3 million tons (91% capacity utilization), and the capacity increase for 1997 is then reduced to a more believable 5%.This is in line with the increase in the daily capacity (a reported, not calculated, statistic).The capacities for earlier years could be similarly recalculated, using an average for downtime within the range of 25 to 30 days. It should be noted that, although the 1997 annual capacity (as defined) data are more accurate than those of recent preceding years, the 1997 data may still incorporate errors for plants that reported realistic (30 days or less) scheduled downtime totals—these data were not questioned but some could still be wrong.

In 1997, the average plant operational capacity was 0.75 million tons per year; average annual capacity per kiln was0.41 million tons. As shown in table 6, (entirely) dry-process plants accounted for about 72% of total clinker production and wet plants for 26%; combination plants accounted for the remainder.

Excluding the clinker used directly in the manufacture of masonry cement (not broken out but estimated at about 2.3 million tons), the remaining clinker produced was sufficient to make approximately 76 million tons of "straight" portland cement, or 79 million tons if the imported clinker *(see table 5)* is included. Thus, unlike the case in 1996 where stockpiles were drawn down to meet an apparent clinker deficit of about 1 million tons, clinker production plus imports in 1997 were adequate for cement production needs, implying no significant net changes to clinker stockpiles for the year.

The top five clinker-producing States continued to be, in descending order, California, Texas, Pennsylvania, Missouri, and Michigan. Depending on the ownership combinations used, the top 5 companies had about 40% of total U.S. clinker production and capacity, and the top 10 companies had between about 60% and 64% of both. In terms of ranked clinker production, the order of the top 10 companies is ownership-dependent, and was (in declining order) Holnam, Inc.; Southdown, Inc.; Lafarge Corp.; Ash Grove Cement Co.; Essroc Materials, Inc. (including San Juan Cement); Blue Circle Inc.;Lone Star Industries, Inc.; Medusa Corp.; California Portland Cement Co.; and Lehigh Portland Cement Co. (excluding CBR).

Raw Materials and Energy Consumed in Cement Manufacture.—The nonfuel raw materials used to produce cement, most of which were consumed to manufacture clinker, are shown in table 5.As normal, about 83% of the raw materials mix was limestone and other calcareous rocks. Overall, the mass ratios among various major raw materials, and of these to clinker produced, are essentially the same for both 1997 and 1996.

Given increasing environmental interest in pozzolan consumption and data thereon, the substantial relative increase in consumption of blast furnace slag in 1997 is noteworthy because it is in contrast to the (surprising) decrease in sales of blended (with slag) portland cement shown in table 15.In 1996, the ratio of blast furnace slag consumed *(see table 5)* to the sales of blended (with slag) cement was about 17%, but in 1997 the ratio was 72% (the ratios assume a negligible volume of sales of blends containing natural pozzolans within the same table 15 category).Although there is no unique proportion of slag in blended cements, an amount of 15% to 40% would be common. Accordingly, the slag consumed in 1996 could easily "fit" into the tons of blended cement sold and, therefore, it was concluded for that year that essentially all of the blast furnace slag consumed was granulated slag used as a pozzolan. For 1997, however, although a proportion of70% slag or more in blended

cement is certainly possible, this proportion (and the large "recipe" shift it would represent) is unlikely for the country overall. This suggests that there could be a disproportionality in 1997 between the tons of slag consumed and the tons of slag-containing blended cements sold. It is also possible that the slag consumption data for (especially) 1997 includes nongranulated (i.e., nonpozzolanic) varieties of blast furnace slag, or even misreported steel slag, both of which could be used as a kiln feed. Another possibility is that some of the slag reported as consumed in 1997 may be in excess of what was used to make portland cement—the excess having been for the manufacture of ground slag product or slag lime cements, which are not included in table 15.Limited proprietary data from slag processors, which in any case exclude the disposition of imported granulated slag, are inadequate to resolve this apparent slag consumption imbalance.

In contrast to blast furnace slag, the data for fly ash 1996-97 are in accord with the sales of blended cements that contain fly ash *(see table 15)* in terms of trend, but not in terms of proportionality. In any case, the amount consumed in both years remained well in excess of what could be accommodated by the cement sales. Accordingly, as in 1996, it is likely that the bulk of the fly ash consumed in 1997 was used as kiln feed; about 40% of the fly ash consumption increase shown was due to that of included bottom ash, which is only used for kiln feed.

Consumption of fuels, by kiln process, is shown in table 6.Overall, the consumption of coal (or coal plus coke) relative to clinker production were substantially unchanged in 1997.A significant increase in the burning of tires apparently offset modest declines in the burning of other solid wastes and of coke. The biggest change in 1997 was seen in the 37% increase in fuel oil consumption, apparently due to low oil prices during the year. The increase appeared to be at the expense of liquid wastes and, particularly at wet kilns, of natural gas.

Table 7 shows electricity consumption by the cement industry. For integrated plants, the consumption data are differentiated by kiln process type. Electricity consumption at integrated plants is dominated by the raw meal and finished cement comminution circuits. However, in modern dry lines significant amounts of electricity also are used to operate various fans and blowers in preheater and precalciner equipment. Thus, dry-process kiln lines—at least those equipped with preheaters and/or precalciners—consume more electricity than equivalent capacity wet-process lines. In 1997, overall per-ton (of cement) consumption of electricity decreased slightly compared to that in 1996; within this modest improvement was a significant decline in unit consumption by wet kilns. The improved wet kiln performance likely reflected various plant upgrade projects.

New to this edition of table 7 is the inclusion of electricity consumption by the dedicated grinding plants. The grinding plants reported an average consumption of 65 to 68 kilowatt hours per ton of cement produced, equivalent to 47% to 49% of the total unit consumption by integrated plants. Although the breakout data were unavailable, it is likely that the dedicated grinding plants consume more electricity on a unit basis than do the combined equivalent functional parts (finish milling, conveying, packaging, storage, and loading circuits) of the integrated plants. This is because the dedicated grinding plants have additional stand-alone functions (e.g., extra materials handling and storage) that might not be charged solely to the grinding and followup functions at integrated plants. Further, some of the clinker grinding plants also grind slag (in some cases, well in excess of blended cement needs) for sale either directly or within slag lime cement. It is likely that at least some of the electricity consumption for such (excess) grinding and handling was included in the data provided to the USGS. Alsop (1998) reports that, for a typical "world" integrated plant, the finish grinding and followup functions account for 41% of the plant's total electricity consumption. For his exemplar, this was 50 kilowatt hours per ton out of a total of 116 kilowatt hours per ton; accordingly, his reference appears to be to a more energy efficient facility than is represented by the U.S. average shown in table 7.

Consumption

Consumption of cement can be measured in more than one way. Table 1 shows the calculated apparent consumption for the country (excluding Puerto Rico).Apparent consumption is a commonly used statistic for commodities and is a mass balance among production, imports, exports, and changes in stockpiles. Although corrected for this report, values for apparent consumption of cement for earlier years prior to 1991 are somewhat too large because they contain a double counting of clinker imports, which should be deducted because the derived cement is already included within the production data. Also, apparent consumption data prior to 1991 are inconsistent in their inclusion or exclusion of trade and production data for Puerto Rico. For all years, the U.S. exports (may) include clinker, but any error introduced thereby is small. For consistency, the beginning year stockpiles data used in the calculation have been set as equal to the preceding yearend inventory, but this is not always in accord with the actual survey data for January 1st stocks. Also, the cement trade data used are for all types of hydraulic cement, not just the (dominant) portland and masonry varieties that compose production and stockpiles. Apart from these issues of data quality, the main problem with "apparent consumption" is that it includes cement moving as inter- and intracompany transfers (i.e.,material that has not yet been consumed) as well as material sold to final customers. On the other hand, the import data within "apparent consumption" are from the Department of Commerce, and may include material brought by spot importers—these imports would likely be missed by the USGS surveys of long-established terminals.

The best measure of true cement consumption levels in the United States is the amount of cement sold (shipped) to final domestic customers. In contrast, shipments by one cement producer to another, whether or not of the same company, are not counted until, ultimately, the cement is transferred to a final customer. The definition of who is and is not a "final customer" is left to the reporting cement producer, but is generally understood to include concrete manufacturers, building supply dealers, construction contractors, and the like. The designation ignores the possibility that a customer might put some cement into stockpiles extending beyond yearend (to be "consumed" the following year) or might resell cement to other users. There are no data on such storage or transfers, but they are believed to be small—probably no more than 5% of any 1-month's

shipments—and would likely balance out over a period of months.

Cement shipments data and derivations therefrom are given in tables 8 through 15.Although some of the tables are superficially similar, it is important to note that these tables reflect two different data-collection methodologies, which yield some results that are not strictly comparable. The best consumption data are those of tables 8 and 9, which are annualized compilations of shipments data collected monthly from the cement-producing companies and from independent cement importers. The monthly surveys commonly are returned on a consolidated basis—one form representing a company's entire cement shipment activities (to final customers) including, importantly, those of its importation and distribution terminals. In contrast, tables 10 through 15 are based on the annual surveys sent to all of the cement-producing plants and certain import terminals. The annual forms are returned on an individual, not consolidated, operations basis. On the annual form, a cement manufacturing plant may report the shipments (to final customers) of distribution (including imports) terminals, but only to the extent that the activities of the terminals are known to the plant. Importantly, if a terminal acts partly or totally independently of the reporting plant, and did not itself return a survey form, then some or all of the shipments from the terminal may remain unreported to the USGS.

That all or part of the activities of some terminals are missing from the USGS cement surveys is strongly suggested by the fact that, over the years, the differences in the national shipment totals—especially for portland cement—from the two survey types have been significant. For example, total portland cement shipments to final customers in 1997 are given as 92.8 million tons in table 8 (monthly survey data) but only as 86.7 million tons in table 11 (annual survey data).For 1996, table 8 shows (revised) shipments of 87.5 millions tons, but table 11 shows 80.1 million tons. Both tables 8 and 11 include shipments of imported cement by mills and independent importers, and of cement made from imported clinker. The difference in total shipments—6.1 million tons in 1997 and 7.4 million tons in 1996—most likely reflects the activities of terminals not captured in the annual surveys (that is, on table 11).The monthly survey-based data (*table 8*) show the larger shipments of portland cement, are undoubtably more complete, and are thus preferred.

In a seeming logical contradiction, although the table 8 data for masonry cement are also the better measure of consumption, the table 8 national totals can for some years be slightly smaller than those in table 12.This is most likely explained by the fact that some companies' monthly surveys have some (generally small) shipments of portland lime and/or plastic cement misreported as being portland cement instead of masonry cement. This problem was identified in early 1998, and corrections to (identified) errors were sought only back through 1996.The 1997 data and the revisions for 1996 shown on table 8 reflect such corrected data as have been received by the USGS, but it is unclear if all misreporting companies have yet submitted corrected data, or if all of the errors have even been identified. The annual surveys appear to be substantially free of this problem.

Comparison of tables 8 with tables 11 and 12 reveals another important difference in the presentation of shipments data. Table 8 data are presented on an individual State basis, but some of the data in tables 11 and 12 (and others) are grouped on a multi-State basis where needed to conceal proprietary individual plant data. This (grouping) precaution is necessary because the data in tables 11 and 12 represent only the activities of plants and terminals within the given State. Except for cement imported (and subsequently shipped to customers) by these same facilities, the shipments shown all originated within the given State. However, the tonnages shown in tables 11 and 12 for a given State merely represent the total cement shipped by survey respondents in that State to final customers somewhere. The customers are not necessarily in the same State, and hence the data do not equate with consumption in that State. Thus, only the national totals in tables 11 and 12 represent a true "regional" consumption. In contrast, table 8 shows the individual State destinations of the shipments to final customers (i.e. consumption within that State), regardless of the State (or country) of origin of the cement. Because any number of companies or locations could ship to customers in a given State, with the exception of a few data for masonry cement, individual State data in table 8 do not require proprietary concealment.

As an example of the tonnage differences between the two data sets, Missouri is shown on table 8 as being the final customer destination (i.e., consumer) of 2.311 million tons of portland cement (that was produced somewhere), but table 11 shows Missouri (facilities) as having shipped 5.563 million tons of portland cement to final customers (somewhere).Clearly, Missouri was a net exporter of portland cement. In contrast, Florida is shown in table 8 as consuming 6.435 million tons of portland cement, but table 11 shows Florida facilities as having shipped only 4.750 million tons to final customers. Clearly, Florida was a net importer of portland cement.

Because they are from the same annual surveys, the data (national totals) in tables 10, 14, and 15, match those in tables 11 and 12, but not those in tables 8 and 9.

National Consumption.—Overall U.S. consumption of portland cement in 1997 increased 6.1% to 92.8 million tons, as shown in table 8.The component of shipments consumed that was imported cement grew 19.6% to 13.8 million tons. Masonry cement consumption increased by a modest 1.6%, but part of this increase was due to corrected monthly reporting (especially for 1997) by some companies for portland lime and/or plastic cement shipments that had hitherto been reported as being portland cement. As noted in the introduction to this report, the consumption of masonry cement shown likely under represents true consumption for the country because some such cement may be mixed at the job site, using purchased portland cement and various additives, rather than at the cement plant.

Construction spending overall increased 2.8% in 1997 from that in 1996 to $507.5 billion (1992 dollars), according to Bureau of the Census data quoted by the Portland Cement Association (1998).Within this total, residential construction grew 2.9% to $218.2 billion, as a result of a 9.8% growth to $19.1 billion in multifamily dwelling construction; that for single family units was stagnant at $136.5 billion. Compared to the 5.2% growth in overall residential spending in 1996, the 1997 performance was modest, but the 1996 performance was in comparison to a lackluster 1995.Growth in 1997 reflected continued, and generally slightly declining, low mortgage rates. Nonresidential building construction rose 4.6% in 1997 to $136.4 billion. Public

sector construction rose 2.2% to $117.9 billion, led by a 5.4% increase in road construction to $35.1 billion. It is interesting to note that, as in 1996, the overall rate of increase of construction spending was less than the rate of increase, by tonnage, of cement consumption noted above. For 1997, this appears to be partly due to modest increases in cement prices (see Values section below), but also (for both years) appears to reflect a somewhat higher "penetration" rate of cement in overall construction—that is, more cement was consumed per dollar of construction than in years past. Unfortunately, the survey data are not adequate (see the Cement Customer Types section) to assess wherein what usage types this penetration (increase) might be occurring.

As shown in tables 8 and 9, most States and all regions showed consumption increases for the year. Of the few States that consumed less portland cement in 1997, almost all were small consumers. For some States, the annual tabulation masks some short-term (monthly) declines that were, generally, the result of adverse weather conditions. The largest relative growth region was the Pacific District, which was powered by a 13% increase in consumption by California, the largest consuming State. The Northeast region, led by Massachusetts (up 17.5%), New York (9.9%), and Pennsylvania (7.2%), also showed strong growth. Besides these States, major (consumer) States that showed strong growth were Arkansas (up 11.5%), Indiana (9.9%), Iowa (8.6%), New Jersey (15.6%), Texas (6.7%), and Washington (8.1%). For the country, the five largest portland-cement-consuming States were, in declining order, California, Texas, Florida, Ohio, and Georgia—the order unchanged from 1996 except for a reversal of the top two. Overall, the South continued to be the largest consuming region. The 1997 data for Georgia and South Carolina understate true consumption because of the startup of two import terminals acting as captive suppliers to their parent local ready-mixed concrete companies. The terminals were not part of the 1997 surveys but, based on the import data in table 18, their activity in 1997 was believed to be very small.

Table 10 shows portland cement shipments to final customers in terms of transportation method. As in 1996, most shipments were directly from the plant to the customer and were mainly of bulk cement. Truck transport continued to dominate deliveries to final customers, but railroads were the largest mode of delivery from plant to distribution terminals. The only significant changes in transportation modes in 1997 were that barged shipments from plants to terminals grew at the expense of rail transport, and barged shipments to final customers were virtually eliminated.

Values.—The value data shown in tables 11 through 13 represent ex-plant valuations provided by the plants and import terminals for their total shipments to domestic final customers of gray portland cement, white cement, and masonry cement. In recognition of the highly proprietary nature of value data and the misgivings of some companies about providing such data at all, values are not queried for shipments by individual types of portland cement (although the tonnages, by type, are reported and are shown in table 15), nor is there differentiation of bulk shipments from container (bag) shipments. Container shipments would be expected to have relatively high unit values. Except in table 13, the white cement data have been lumped in with those for gray portland cement. Notwithstanding these obscuring protections, almost one-fourth of the respondents did not provide value data for the 1997 survey, about the same as in previous years. In such cases, the values supplied by other plants in the same market area were averaged and applied as an estimate; the number of plants so averaged varied regionally.

Traditionally, the values sought have been "mill net," which can be defined as the (sales) value at ("free on board" or f.o.b.) the manufacturing plant, excluding any discounts, and excluding shipping charges to the final customers. For independent terminals, particularly import terminals, the equivalent statistic sought would be the f.o.b. terminal value. In the case of imports, this would essentially represent the c.i.f. (cost, insurance, freight) value of the imports plus unloading and storage costs plus the terminal's markup. However, it is evident that some facilities have provided value data that was calculated differently.

Given the entrained problems with the value data, the reader is cautioned that the values shown are merely estimates, despite the fact that, to preserve a time series with previous editions of this report, they are presented unrounded. The unit value data should be viewed solely as estimated regional indicators or indices, good (only) to perhaps the nearest $0.50 or $1.00 per ton, and suitable only for crude comparisons among districts and years. Most especially, the unit value data cannot be viewed as regional shopping prices for cement. It may be assumed that the data for portland cement are dominated by the values of the Types I and II varieties.

The total ex-plant value of portland cement shipments to final domestic customers, as shown in table 11, rose almost 12% to about $6.3 billion in 1997, reflecting both an 8% sales volume increase and, within the aforementioned data constraints, an average ex-plant unit value increase of 3.3%.If the average price shown is applied to the shipments (consumption) data in table 8, the 1997 total rises to $6.7 billion. This performance follows a 14% increase in total value, and about a 5% increase in unit value, in 1996.The substantially larger volume of imports in 1997, which averaged only a 2.4% increase in c.i.f. price (*see table 19*), may be partly responsible for the relatively moderate increase in the overall unit value of cement sales in 1997.

The regional breakouts in table 11 represent the location of the reporting facilities, not the location of consumption, for the cement sales shown, consequently, the data shown are only crude indicators of regional values. Within this constraint, and ignoring changes of $1.00 per ton or less (statistically probably indistinguishable), unit values increased modestly for most regions in 1997.The significant decline shown for eastern Pennsylvania probably reflects a too high value in 1996, although it is possible that the 1997 decline could reflect an influx of low cost imports (imports into the New York Customs District *(see table 18)* showed an 8.5% reduction in unit c.i.f. value in 1997.

Table 12 shows the distribution of masonry cement sales and the values thereof, in terms of the location of the reporting facilities. The average unit value of sales in 1997 increased only about 1% (this may not be statistically significant) to about $94 per ton, for a total of about $344 million. As noted above, table 12 shows a slightly higher total sales volume of masonry cement for the country than does table 8 because the latter may still exclude a small amount of portland lime or plastic cement mistakenly reported to the USGS as sales of portland cement. The unit value in table 12 applied to the total volume in table 8

would yield a total value of sales of $340 million.

The only data for domestic delivered prices for cement are those for Type I portland (per short ton) and masonry cement (per 70-pound bag) published monthly by the journal Engineering News Record (ENR).The data represent a survey of customers (likely to be ready mixed concrete producers for portland cement and building supply depots for masonry) in 20 cities in the United States. The 20-city average delivered price in 1997 for Type I portland converts to $83.04 per metric ton, up by 3.3% from the 1996 price, with a range over the year of only $2.55 per ton. The prices showed a general increase from January to December ($83.87).The $10.45 per ton difference between the average ENR price and the average unit value in table 11 is an indicator of the approximate delivery charge to final customers. The ENR specific city data show a number of regional price differences, some of which differ significantly from those shown in table 11.The variations could reflect regional differences in shipping methods and costs. The prices for some cities covered, however, did not vary at all over the year, making questionable the validity of the data, save for the fact that the overall percentage price increase for the ENR survey is consistent with that in table 11.The ENR 20-city average masonry cement price for the year was $4.58 per bag (literally converts to $144.25 per ton), up by 2.5%; the large difference in "price" between this and the average in table 12 is probably a combination of packaging, handling, and delivery charges.

Cement Customer Types.—Data for 1997 on portland cement shipments to final customers are shown in table 14, broken out by customer (user) type and region. Again, the regional splitouts represent the locations of reporting facilities, not necessarily the locations of the consumers. As with the value data, the user-type data must be viewed as crude estimates.

The problem with the user-type data lies in the fact that the survey requests more details (user categories) than many companies are able to provide. A few cement plants seem not to track their customers by user type at all, and many others track their sales only in terms of very broad user types, such as "Concrete product manufacturers."In the latter case, the shipments would be entered on the form either all under the broad classification header (Concrete products), or under its breakout subheading "other."Thus, the subheadings "other," intended to capture miscellaneous uses not otherwise broken out, instead misleadingly serve largely as a catch-all. Even for companies that track customer user types in detail, the user categories that they employ might not match those of the survey. And there are some categories that present assignment ambiguities. Perhaps the most important of these are cases where a cement plant knows how much of its cement gets used by a ready-mixed concrete manufacturer customer for the purpose of building or repairing roads. The dilemma, then, is whether to register those tons under the "Ready-mixed concrete" category or the "Contractors—road paving" category. Another example would be the "Government agencies" use category on the questionnaire, wherein the "Government" use could include ready-mixed concrete, or road paving, or other duplicative use(s).Further, although generally listed as exact tonnages, some company responses calculate to simple (broad) percentages of the total shipments—the breakdown being the "best guess" of that cement plant. In a few instances, the apportioning appears to have been guided by past published breakdowns.

To a significantly greater extent than in previous years, plants that initially provided inadequate details for user types on the 1997 survey were solicited on a followup basis for additional details, with, however, mixed success. Certainly, the major use categories are better represented than in past years, if only by companies' best guesses, but some of the minor use categories remain questionable (probably under represented).Importantly, table 14 for 1997 has far fewer tons lumped under the "other" and "Government and miscellaneous" categories. Although believed to be more accurate than in previous years, the data still contain a number of estimates and, although presented in unrounded form, probably should not be taken as being accurate to more than two significant figures.

Notwithstanding these limitations, the data in table 14 clearly indicate that the dominant customer type for portland cement in 1997 continued to be ready-mixed concrete producers, accounting for 72% of the total. This is in accord with data for recent past years, once allowance was taken for a share of ready-mixed concrete lumped under the past years' "Government and miscellaneous" and "Road paving" categories. Unfortunately, to a significant degree the improved subcategory assignations of the 1997 data within "Concrete product manufacturers" and "Contractors" preclude their direct comparison with data from preceding years, at least in terms of usage trends. Sales to oil well drilling consumers increased by 35%, but this may underestimate the true sales volume because, where estimates were included, they were only to assign reported sales of oil well cement. No "ordinary" (e.g., Types I and II) portland cements were assigned to this user category on an estimated basis, yet "ordinary" cements can be used in shallow drill holes. The increase shown reflects a higher level of drilling activity during the year, as evidenced by the 19% increase in the drill rig count (Oil & Gas Journal, 1998).Sales to mining customers, as shown, are an almost sixfold increase over those in 1996.However, although—particularly in the gold industry—there was greater reliance on underground mining (for which cement is used in backfill), the level of this activity almost certainly did not increase by the percentage indicated for the cement shipments, which suggests some under reporting of cement consumption for mining in 1996.Likewise, the doubling of sales for waste stabilization purposes may reflect incomplete data.

Types of Portland Cement Consumed.—As shown in table 15, portland cement consumption in the United States continued to be dominated by general-use Types I and II. Within the broad use of the portland term, Types I through V accounted for more than 96% of total shipments. Of these main varieties, Type V cement, which is resistant to so-called sulfate attack, showed the largest relative increase during the year. Of the less common varieties, oil-well cement showed an 18% relative increase in shipments, owing to a large increase in drilling activity during the year, as noted above. After having increased significantly in 1995, consumption of slag-blended cement was largely stagnant in 1996, and decreased significantly in 1997.This decline was unexpected given that, based on proprietary sales data for domestic granulated slag and the general paradigm that blended cements are more "environmentally friendly" than "straight"

portland, the market was believed to have grown for slag-blended cements. The table 15 decline could reflect a greater reliance by the concrete manufacturers on purchases of domestic or imported granulated slag which they then mix themselves. Alternatively, the decline could reflect market substitution of other types of blended cement, especially of blends with fly ash. Table 15 shows a five-fold relative increase in sales in 1997 in the category that includes blends containing fly ash. Overall, blended cement consumption increased 14.4% during the year.

Foreign Trade

Trade data from the Bureau of the Census are shown in tables 16 through 21.Exports of hydraulic cement (all types) and clinker decreased slightly in volume and increased slightly in value, but the overall volume of exports is so small as to render such small shifts meaningless. The bulk of the exports continued to be to Canada.

Tables 17 and 18 show total imports of hydraulic cement and clinker for 1997 and 1996.Unlike the relatively stagnant level of imports in 1996 (which increased only 2.2% over those in 1995), imports in 1997 increased by 24.3% (compared with 1996 levels).The unit value of the imports, however, rose only 2.7%, which likely constrained price increases for domestic cement, at least in markets having access to imports.

The cement component of imports (data in table 17 minus the clinker imports in table 21) was 14.6 million tons, up 25.6% cement from imports in 1996.Gray portland cement imports represented 96% of total cement imports, and were up 25.4% (tons); the c.i.f. unit value was up only 2.5%, to $50.05 per ton. This continued to be substantially below the unit sales value of domestic shipments, but excluded markups by terminals. The cheapest cement was from Mexico (c.i.f. value of $39.22 per ton).

The Customs districts of entry for imports of hydraulic cement and clinker are shown in table 18.Large relative increases were seen particularly for West Coast and Gulf of Mexico import terminals. A significant contributor to the West Coast increase was the reopening early in the year of the MCC Lucky terminal, owned by Mitsubishi Cement Corp., in Long Beach, CA, which had been idle since its construction in 1991 (World Cement, 1997b).Canada continued to be the largest source of cement imports, but its sales to the United States in 1997 increased only modestly, reflecting in part, importation infrastructure constraints. Other than Canada, most major traditional sources showed substantial increases in sales to the United States in 1997, particularly Colombia and Greece. One notable exception was Mexico, imports of gray portland from which declined 25%, evidently the result of burdensome antidumping tariffs and failed appeals thereof. Of nontraditional sources, imports from China and Turkey increased dramatically. White cement imports *(see table 20)* were up by one-third compared with levels in 1996, although the latter had shown a decline of 10.6% compared with imports in 1995.The major sources continued to be Canada, Denmark, Mexico, and Spain. The average c.i.f. price declined 4% to $104.77—well below the domestic sales value (for which, however, the data are weak) shown in table 13.Imports of white cement, per table 20, were equivalent to 82% of the sales shown in table 15 in 1997, as opposed to 63% in 1996 and 79% in 1995.

Hydraulic cement clinker imports increased by 19%, as shown in table 21.The c.i.f. value increased 3.6% to $50.13 per ton, virtually identical with the unit value for gray portland cement; however, these amounts are inflated by their inclusion ofvery high unit value material (largely aluminous cement clinker) from France and some miscellaneous (“Other”) countries. Removing these yields a remainder that is largely portland cement clinker and which amounted to about 2.72 million tons, up 9%, and worth about $47 per ton, up 4%.

Although Canada continued to be the dominant source of clinker imports, the tonnage taken in 1997 fell almost 19%.Based on Customs district of entry data for clinker imports in the monthly surveys, it appears that the decline was of waterborne deliveries to South Atlantic and Gulf ports where it was replaced, to a major degree, by a 36% increase in imports from Venezuela. After a hiatus in 1996, Turkey reemerged as a significant import source for clinker.

World Review

World hydraulic cement production is shown in table 22 and amounted to about 1.5 billion tons in 1997.The data incorporate estimates for a number of countries, and the production of cement for some countries may include their exports of clinker. Accordingly, the minor annual world total increases shown for the years 1995-97 are within the likely range of error for the summations and are thus probably of no statistical significance. Further, although the data are supposed to include all forms of hydraulic cement, for some countries (notably the United States), it is likely that the data are, in fact, not all-inclusive.

China continued to be, by far, the largest cement producer in the world, with about one-third of the total output. A strict ranking of the remaining top 15 producers cannot be fully fixed, but would appear to be, in descending order, Japan, the United States, India, the Republic of Korea, Brazil, Germany, Turkey, Thailand, Italy, Spain, Mexico, Russia, Indonesia, and Taiwan. The top 15 countries accounted for 74% of the world total in 1997, and among these countries are about 10 that have accounted for the majority of the growth in world production. China’s growth, in particular, has been explosive for the years shown (except for 1997, where its output increased only slightly).For the period 1993-97, China has accounted for about 125 million tons, or 56% of the total world increase. Among the other major producers, India’s output has increased about 26 million tons during this period, Brazil by more than 13 million tons, Korea by almost 13 million tons, and the United States and Thailand by about 9 million tons each. India’s growth has been so rapid that it would appear destined to overtake the United States within 1 or 2 years. In contrast, Russia has experienced a 23-million-ton decline in output since 1993.

Comparison of production levels among some countries can be misleading, however, unless they are made for output of similar-quality cements. For example, portland and related cements from clinkers manufactured in large rotary kilns are generally considered to be of higher and more consistent quality than cements made in small (“village-scale”) vertical shaft kilns. The

vertical shaft kilns might produce cements suitable for the construction of small houses and similar edifices, but for modern highways, large bridges and dams, tall buildings, and the like, cements from modern rotary kilns are preferable. Unfortunately, there are few if any data on the world production split between vertical shaft kiln plants and modern rotary kiln plants; the former are almost universally found in so-called developing world countries, but the same countries may also have enormous, state-of-the-art rotary kilns. Where financing and demand permit, most countries having shaft kilns are replacing them with rotary kilns. The giant example of the difference in output between kiln types is, once again, China. Cement production in China, based on recent reviews (e.g., Hargreaves, 1997; Rong and others, 1997), comprised in 1997 about 60 million tons of high- or export-quality cement from a relatively small number of medium and large rotary kilns and about 430 million tons of cement of uncertain quality from several thousand small shaft kilns (many of which are being phased out).

On a regional basis, Asia (including Australasia) had the largest cement production in 1997, accounting for about 58% of the world total. Europe was the next largest producing region, with 15% (Western Europe alone was 12%) of the total; followed by North America (including Mexico), 8%; the Middle East (including Turkey), 7%; Central America and South America, 5%; Africa, 4%; and the former Soviet Union, 3%.Asia has accounted for 88% of the total world growth in cement production for the period 1993-97.

Were it practicable to produce an accurate list of all the ongoing or planned world projects to build new, or upgrade existing, cement plants, the compendium would be very lengthy. Given the production and production growth distributions noted above, it is no surprise to find that a majority of these projects are in Asia, particularly in Southeast Asia. As state-owned plants in Eastern Europe and elsewhere have been privatized, they have attracted investment interest by, in the main, the same major European and Mexican cement companies that dominate the production of cement in Western Europe, the former Soviet Union, and the Americas. Many of the Southeast Asian projects, on the other hand, have been more locally organized and financed. By comparison, new projects—particularly for greenfields plants—in Western Europe and in the United States and Canada have been relatively few. Except mainly for Egypt, there have been few significant cement projects in recent years in Africa.

The economic crisis that manifested itself late in 1997 in Southeast Asia and which has subsequently spread to many parts of the world appears already to be slowing the completion of some ongoing projects and the startup of new ones.

Outlook

Over the medium to long term, world cement consumption and production is anticipated to grow at about 2% per year. However, the Southeast Asian economic crisis mentioned above has necessitated a revision to cement forecasts and to most other world near-term economic forecasts. Although the economic downturn in Southeast Asia has subsequently spread elsewhere, it can be argued that it has yet to do so with the same degree of severity. Nevertheless, because Asia has been the locus of the majority of world production, of growth in cement consumption, and of new or planned capacity, any major economic downturn in this region would argue for, at the very least, a stagnation in both world cement consumption and production in the short term (e.g., for the period 1999-2003).A contraction of 1% to 2% per year would be equally possible, although data inconsistencies for many of these countries could make documentation of this difficult. The cement industries of Asia (especially Southeast Asia) appear to be particularly vulnerable to the current crisis, compared with their counterparts elsewhere, for a number of reasons. Much of the recent growth in Asian cement consumption and production capacity has been tied to high levels of public sector construction spending and many of the planned new capacity projects have been predicated on continued high levels of such. A large portion of this spending has now been put into abeyance or is in jeopardy. Many of the new plants and planned facilities have been projects of local companies or consortia rather than of large, multinational, cement corporations, and many of these projects have been financed by borrowing from local banks, at high debt to equity ratios (Roy, 1998).Financing of these projects (which each cost tens to hundreds of millions of dollars) has been made very difficult, particularly for the local companies, by the devaluations that have occurred to the local currencies and the fact that these companies, and many of the local banks, do not have significant hard currency reserves.

Cement industries in other regions of the world can also expect to be affected as the economic downturn spreads, but it appears likely that for many of these regions the decline could be mitigated to some degree by an overall lesser reliance on public sector spending. Further, in these regions, most of the companies involved are large, multinational concerns having the ability to spread their risks and draw on resources, worldwide, and which are not as vulnerable to local currency value fluctuations. Also, for the developed world, the more established and generally more diversified nature of the economies would argue for fewer sudden shifts in construction spending.

The U.S. economy has been relatively unaffected from the Asian economic crisis in 1998 and continued buoyant during the year, with the construction sector benefitting from continued very low interest rates. Data available through the third quarter of 1998 yield a projection of U.S. consumption of portland plus masonry cement for the year that could, for the first time, exceed 100 million tons. In the near term beyond 1998, some slow weakening of the U.S. construction market, particularly for buildings, could occur, particularly on the West Coast, where the economies are vulnerable to diminished levels of U.S. exports to Asia. Any decline would likely be mitigated by continued low interest rates and by increases in public sector construction spending resulting from the 1998 passage of a major highway spending bill. Overall, any demand growth in 1999-2003 is likely to be under 3% per year. In contrast, U.S. cement production is slated to rise in 1999 and in the succeeding few years, as several million tons of new capacity (largely at existing plants) is brought on-stream. Given a relatively stable U.S. cement market, the added production would augur for proportionally reduced levels of imports, although there could be

short-term increases due to influxes of inexpensive cement from major producing countries experiencing severe economic downturns. In particular, several Asian countries now have significant excess production capacity and can be expected to seek to export their excess output. Because of local currency devaluations, this cement will likely be inexpensive. For some Asian companies, exports may be constrained by a lack of convenient access to shipping ports or to suitable cement tankers. The ability of these countries to export to the United States is further constrained by limited capacity at U.S. cement unloading port terminals, although this can be offset by the use of self-unloading or silo ships, or by bringing in packaged shipments that can be unloaded at general cargo ports.As of the third quarter in 1998, large increases (over full year 1997 levels) in cement (plus clinker) imports into the United States were being seen for material from China, the Republic of Korea, and Thailand. Any flood of inexpensive imports can be expected to be scrutinized for evidence of dumping.

In addition to standard market factors, a constraint on future domestic cement production will be any imposition of restrictive environmental legislation, particularly that requiring a majority of plants to reduce emissions, or that restricts the ability of the industry to cheaply use waste fuels. If restrictions or taxes on CO_2 emissions are imposed, then the U.S. industry could find itself at a competitive disadvantage to imports from countries exempted from similar restrictions or taxes. Without protective tariffs, or allowing the industry to engage in some sort of trading of emissions credits, some shutdowns of domestic capacity could take place. Any resulting declines in clinker production likely will be offset by increased domestic use of nonclinker components of cement, such as pozzolan or inert extenders.

References Cited

Alsop, P.A., 1998, The cement plant operations handbook, 2d ed.:Tradeship Publications Ltd., Dorking, United Kingdom, p. 222.

Blue Circle, 1997, [untitled]:Blue Circle press release, January 21, 2 p.

Hargreaves, David, 1997, Breaking down barriers: International Cement Review, June, p. 20-29.

International Cement Review, 1997a, Hawaiian exit: International Cement Review, June, p. 17.

———1997b, Southdown reports 19% gain: International Cement Review, November, p. 14.

———1997c, Ssangyong sells US assets: International Cement Review, October, p. 5.

———1998a, [Untitled]:International Cement Review, February, p. 49.

———1998b, Devil's Slide expansion: International Cement Review, June, p. 20-30.

Oil & Gas Journal, 1998, Baker Hughes rig count: Oil & Gas Journal, v. 96, no. 2, p. 92.

Portland Cement Association, 1998, Construction put in place: The Monitor, v. 7, no. 12, December 1997 (released March 1998), p. 14.

Rock Products, 1998a, [Untitled]:Rock Products Cement Edition supplement, March, p. 42.

Rong, Peikang, Cui, Yuanshen, Zhang, Yuhui, and Zhou, Qingshan, 1997, China's cement industry in 1996 and development prospects for 1997:World Cement, v. 28, no. 6, p. 5-8.

Roy, Rob, 1998, It was the best of times: International Cement Review, April, p. 27-34.

Southern Tier Cement Committee, 1997, Press release, April 3:Washington, DC, King & Spalding.

Tarmac America Inc., 1997, [Untitled]:Tarmac America Inc. news release, May 5, 1 p.

U.S. Geological Survey, 1997a, Portland and masonry cement [Blue Circle Cement—Harleyville plant]:U.S. Geological Survey Form D15.

———1997b, Portland and masonry cement [Holnam, Inc.—Devils Slide plant]: U.S. Geological Survey Form D15.

———1997c, Portland and masonry cement [Southdown, Inc.—Fairborn plant]: U.S. Geological Survey Form D15.

———1997d, Portland and masonry cement [Southdown, Inc.—Victorville plant]:U.S. Geological Survey Form D15.

van Oss, H.G., 1996, Cement: U.S. Geological Survey Minerals Yearbook, 33 p.

World Cement, 1997a, New US grassfield plant: World Cement, v. 28, no. 6, p. 3.

———1997b, [Untitled]:World Cement, v. 28, no. 7, p. 57.

SOURCES OF INFORMATION

U.S. Geological Survey Publications

Cement. Ch. in Mineral Commodity Summaries, annual.[3]

Cement. Ch. in Minerals Yearbook.[3]

Cement. Mineral Industry Surveys, monthly.[3]

Limestone and dolomite. Ch. in United States mineral resources, U.S. Geological Survey Professional Paper 820, 1973.

Other

American Portland Cement Alliance, Washington, DC.

Cement. Ch. in Mineral facts and problems, U.S. Bureau of Mines Bulletin 675, 1985.

Concrete Products, monthly.

Engineering News Record, weekly.

Industrial Minerals, monthly.

International Cement Review, monthly.

The Monitor, Portland Cement Association, monthly.

Portland Cement Association, U.S. and Canadian Portland Cement Industry: Plant Information Summary: Portland Cement Association, Skokie, IL, Annual.

Rock Products, North American Cement Directory: Intertec Publishing, Chicago, annual.

Rock Products, monthly.

Rock Products Cement Edition, bimonthly.

World Cement, monthly.

World Cement Directory, The European Cement Association, Brussels, Belgium, 1996.

Zement-Kalk-Gyps International, monthly.

[3]Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
SALIENT CEMENT STATISTICS 1/

(Thousand metric tons unless otherwise specified)

	1993	1994	1995	1996	1997
United States 2/					
Production 3/	73,807	77,948	76,906	79,266	82,582
Shipments from mills 3/ 4/	72,770	79,087	78,518	83,607 r/	90,359
Value 3/ 5/ thousands	$4,049,820 r/	$4,844,869	$5,329,187	$5,952,203 r/	$6,622,464
Average value per ton 3/ 6/	$55.65	$61.26	$67.87	$71.19 r/	$73.49
Stocks at mills, 3/ Dec. 31	4,788	4,701	5,814 r/	5,488	5,784
Exports 3/ 7/	625	633	759	803	791
Imports for consumption:					
Cement 8/	5,532	9,074	10,969	11,566 r/	14,523
Clinker	1,507	2,206	2,789	2,401	2,867
Total	7,040	11,280	13,758	13,967	17,389
Consumption, apparent 9/	79,198	86,476	86,003 r/	90,355 r/	96,018
World: Production 10/	1,290,905 r/	1,373,013 r/	1,443,328 r/	1,488,262 r/	1,515,442 e/

e/ Estimated. r/ Revised.

1/ Portland and masonry cement only, unless otherwise indicated.

2/ Excludes Puerto Rico.

3/ Includes cement made from imported clinker. Includes imported cement shipped by mills and import terminals.

4/ Shipments are to final customers. Includes imported cement. Data are based on annual survey of plants and may differ from tables 8 and 9, which are based on consolidated monthly shipments data from companies.

5/ Value at mill (or import terminal) of portland (all types, including white) and masonry cement shipments to final domestic customers. Although presented unrounded, the data contain estimates for survey nonrespondents.

6/ Total value at mill or import terminal of cement shipments to final customers divided by total tonnage of same. Although presented unrounded, the data contain estimates for survey nonrespondents.

7/ Hydraulic cement (all types) plus clinker.

8/ Hydraulic cement, all types.

9/ Production (including that from imported clinker) of portland and masonry cement plus imports of hydraulic cement minus exports of cement minus change in stocks.

10/ Total hydraulic cement. May incorporate clinker exports for some countries.

TABLE 2
PORTLAND CEMENT PRODUCTION, CAPACITY, AND STOCKS IN THE UNITED STATES, BY DISTRICT 1/ 2/

(Thousand metric tons unless otherwise specified)

	1996					1997				
			Capacity 3/		Stocks 4/			Capacity 3/		Stocks 4/
District	Plants active	Production 5/	Finish grinding	Percent utilized	at mills, Dec. 31	Plants active	Production 5/	Finish grinding	Percent utilized	at mills, Dec. 31
Maine and New York	4	2,966	3,348	88.6	234	4	3,147	3,529	89.2	242
Pennsylvania, eastern	7	4,057	5,152	78.7	243	7	4,501	5,084	88.5	236
Pennsylvania, western	4	1,615	2,009	80.4	105	4	1,858	2,045	90.8	129
Illinois	4	2,619	2,871	91.2	149	4	2,594	3,399	76.3	194
Indiana	4	2,347	2,731	85.9	185	4	2,396	2,731	87.8	167
Michigan	5	5,387	6,999	77.0	295	5	5,696	7,243	78.6	287
Ohio	3	1,054	1,588	66.4	62	3	1,043	1,878	55.5	56
Iowa, Nebraska, South Dakota	5	3,931	5,489	71.6	322	5	4,224	5,525	76.4	354
Kansas	4	1,725	1,783	96.7	149	4	1,690	1,783	94.8	134
Missouri	5	4,531	5,150	88.0	410	5	4,731	5,150	91.9	404
Florida	6	3,445	4,667	73.8	280	6	3,747	5,262	71.2	293
Georgia, Virginia, West Virginia	5	2,473	3,700	66.8	219	5	2,577	3,277	78.7	242
Maryland	3	1,609	1,837	87.6	105	3	1,790	1,904	94.0	133
South Carolina	3	2,368	3,075	77.0	85	3	2,515	3,075	81.8	93
Alabama	5	4,326	4,804	90.0	271	5	4,279	4,744	90.2	275
Kentucky, Mississippi, Tennessee	4	2,216	2,474	89.6	187	4	2,316	2,528	91.6	157
Arkansas and Oklahoma	4	2,553	2,889	88.4	191	4	2,714	3,162	85.8	149
Texas, northern	6	3,906	4,712	82.9	270	6	3,887	4,719	82.4	208
Texas, southern	5	4,332	4,726	91.7	218	5	4,393	4,772	92.1	204
Arizona and New Mexico	3	2,217	2,367 r/	93.7 r/	63	3	2,239	2,563	87.4	64
Colorado and Wyoming	4	2,031	2,377	85.4	125	4	2,018	2,445	82.5	100
Idaho, Montana, Nevada, Utah	7	2,216	2,887 r/	76.8 r/	209	7	2,344	2,926	80.1	168
Alaska and Hawaii	1	312	499	62.5	45	1	252	499	50.5	52
California, northern	3	2,610	2,880	90.6	125	3	2,773	2,797	99.1	115
California, southern	8	7,297	7,943	91.9	279	8	7,488	7,957	94.1	313
Oregon and Washington	4	1,655	1,960	84.4	133	4	1,737	2,204	78.8	99
Total or average 6/	116	75,797	90,915 r/	83.4 r/	5,108 r/ 7/	116	78,948	93,198	84.7	5,356 7/
Puerto Rico	2	1,552	2,004	77.4	37	2	1,673	2,004	83.5	31

r/ Revised.

1/ Includes Puerto Rico.

2/ Includes data for three white cement facilities as follows: California, Pennsylvania, and Texas.

3/ Grinding capacity based on fineness necessary to grind Types I and II cement, making allowance for downtime required for routine maintenance.

4/ Includes imported cement.

5/ Includes cement produced from imported clinker.

6/ Data may not add to totals shown because of independent rounding.

7/ Total stocks include inventory, not shown on a District basis, held by independent importers.

TABLE 3
MASONRY CEMENT PRODUCTION AND STOCKS IN THE UNITED STATES, BY DISTRICT 1/

(Thousand metric tons unless otherwise specified)

	1996			1997		
District	Plants active	Production 3/	Stocks 2/ at mills, Dec. 31	Plants active	Production 3/	Stocks 2/ at mills, Dec. 31
Maine and New York	4	102	16	4	107	16
Pennsylvania, eastern	5 r/	170	31	6	187	33
Pennsylvania, western	4	105	16	4	109	14
Indiana	3 r/	W	W	4	W	54
Michigan	5	232	28	5	289	29
Ohio	2	W	W	2	W	W
Iowa, Nebraska, South Dakota	4	W	6	4	W	10
Kansas	3	24	9	3	W	W
Missouri	1	W	W	1	W	W
Florida	4	422	26	4	406	24
Georgia, Virginia, West Virginia	5 r/	376	32	5	382	38
Maryland	2	W	W	3	W	13
South Carolina	3 r/	286	W	3	W	W
Alabama	4 r/	309	37	4	346	48
Kentucky, Mississippi, Tennessee	3	W	W	3	88	9
Arkansas and Oklahoma	4	117	21	4	105	14
Texas, northern	4	W	8	4	110	10
Texas, southern	4 r/	100	7	4	94	8
Arizona and New Mexico	2 r/	W	W	3	W	W
Colorado and Wyoming	2	W	W	2	W	W
Idaho, Montana, Nevada, Utah	3 r/	W	W	2	W	2
Alaska and Hawaii	1	5	1	1	3	1
California, northern	2 r/	W	W	2	W	W
California, southern	3	160	W	3	W	W
Oregon and Washington	1 r/	W	W	3	W	W
Total or average 4/	78 r/	3,469 5/	380 6/	83	3,634 5/	428 6/

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Total or average."

1/ Excludes Puerto Rico (did not produce any masonry cement).

2/ Includes imported cement.

3/ Includes cement made from imported clinker.

4/ Data may not add to totals shown because of independent rounding. Includes Districts indicated by W.

5/ Production directly from clinker accounted for 89% of the total in 1996 and almost 94% in 1997. Production from portland cement accounted for the remainder.

6/ Total stocks include inventory, not shown on a District basis, held by independent importers.

TABLE 4
CLINKER CAPACITY AND PRODUCTION IN THE UNITED STATES IN 1997, BY DISTRICT

District	Active plants 1/ Process used Wet	Dry	Both	Total	Number of kilns	Daily capacity (thousand metric tons)	Average number of days routine maintenance	Apparent annual capacity 2/ (thousand metric tons)	Production (thousand metric tons)	Percent utilized
Maine and New York	3	1	--	4	5	9.7	34.0	3,209	2,968	92.5
Pennsylvania, eastern	2	5	--	7	13	14.5	29.5	4,871	4,274	87.7
Pennsylvania, western	3	1	--	4	8	5.9	26.9	2,000	1,808	90.4
Illinois	--	4	--	4	8	8.1	23.1	2,758	2,412	87.5
Indiana	2	2	--	4	8	8.5	22.9	2,914	2,495	85.6
Michigan	1	2	--	3	8	13.7	22.9	4,645	4,254	91.6
Ohio	1	1	--	2	3	3.3	16.0	1,140	980	86.0
Iowa, Nebraska, South Dakota	--	4	1	5	9	13.4	25.1	4,566	3,937	86.2
Kansas	2	2	--	4	11	5.5	29.8	1,850	1,635	88.4
Missouri	2	3	--	5	7	14.0	25.9	4,711	4,445	94.4
Florida	2	2	--	4	7	9.0	28.0	3,025	2,874	95.0
Georgia, Virginia, West Virginia	1	3	--	4	7	9.3	26.0	3,114	2,449	78.6
Maryland	1	2	--	3	7	5.5	19.9	1,892	1,684	89.0
South Carolina	2	1	--	3	7	7.5	18.1	2,573	2,221	86.3
Alabama	--	5	--	5	6	13.2	18.8	4,553	4,007	88.0
Kentucky, Mississippi, Tennessee	2	2	--	4	5	6.6	20.6	2,275	2,183	96.0
Arkansas and Oklahoma	2	2	--	4	10	7.6	27.7	2,576	2,525	98.0
Texas, northern	3	3	--	6	14	12.9	40.9	4,158	3,727	89.6
Texas, southern	--	4	1	5	6	12.7	25.8	4,340	4,158	95.8
Arizona and New Mexico	--	3	--	3	9	6.5	15.0	2,294	2,170	94.6
Colorado and Wyoming	1	3	--	4	7	6.9	24.1	2,335	1,964	84.1
Idaho, Montana, Nevada, Utah	4	3	--	7	10	7.8	25.5	2,672	2,226	83.3
California, northern	--	3	--	3	3	8.7	37.0	2,893	2,647	91.5
California, southern	--	8	--	8	17	24.3	30.2	8,221	7,177	87.3
Oregon and Washington	1	2	--	3	3	4.9	26.0	1,676	1,466	87.5
Total or average 3/	35	71	2	108	198	240.0	26.4	81,262	72,686	89.4
Puerto Rico	--	2	--	2	2	5.0	24.0	1,698	1,426	84.0

1/ Includes white cement plants.

2/ Calculated on the basis of individual company data using 365 days minus reported days for routine maintenance multiplied by the reported unrounded daily capacity.

3/ Data may not add to totals shown because of independent rounding.

TABLE 5
RAW MATERIALS USED IN PRODUCING CEMENT
IN THE UNITED STATES 1/ 2/ 3/

(Thousand metric tons)

Raw materials	1996	1997
Calcareous:		
Limestone (includes aragonite, marble, chalk)	80,016	83,770
Cement rock (includes marl)	25,746	25,704
Coral	682	653
Aluminous:		
Clay	4,747	4,434
Shale	4,202	4,010
Other (includes staurolite, bauxite, aluminum dross, alumina, volcanic material, other)	1,072 r/	323
Siliceous:		
Sand and calcium silicate	2,153	2,322
Sandstone, quartzite, other	638 r/	775
Ferrous: iron ore, pyrites, millscale, other	1,536 r/	1,452
Other:		
Gypsum and anhydrite	4,126	4,274
Clinker, imported 4/	2,133	2,585
Blast furnace slag	133	460
Fly ash 5/	1,478 r/	2,067
Other, n.e.c.	51 r/	35
Total 6/	128,713	132,865

r/ Revised.
1/ Includes Puerto Rico.
2/ Nonfuel materials only.
3/ Includes portland and masonry cement.
4/ Outside purchases by producing plants; excludes purchases of domestic clinker.
5/ Includes bottom ash as follows: 1996--220; 1997--523.
6/ Data may not add to totals shown because of independent rounding.

TABLE 6
CLINKER PRODUCED AND FUEL CONSUMED BY THE CEMENT INDUSTRY
IN THE UNITED STATES, BY PROCESS 1/ 2/

	Clinker produced			Fuel consumed					Waste fuel		
Kiln process	Plants active	Quantity (thousand metric tons)	Percentage of total	Coal (thousand metric tons)	Coke (thousand metric tons)	Petroleum coke (thousand metric tons)	Oil (thousand liters)	Natural gas (thousand cubic meters)	Tires (thousand metric tons)	Solid (thousand metric tons)	Liquid (thousand liters)
1996:											
Wet	35	18,502	25.8	2,343	101	492	30,158	223,987 r/	42	54	649,978
Dry	74 r/	51,777 r/	72.2 r/	6,217 r/	357	776	32,789 r/	413,383 r/	145 r/	18	260,175
Both	2 r/	1,427 r/	2.0 r/	203 r/	--	28	--	72,286 r/	4 r/	--	--
Total 3/	111	71,706	100.0	8,764	458	1295	62,948 r/	709,656 r/	191	72	910,153
1997:											
Wet	35	19,090	25.8	2,623	118	343	39,421	173,718	69	55	671,385
Dry	73	53,481	72.2	6,184	233	917	46,814	433,908	194	13	163,795
Both	2	1,540	2.1	228	--	28	--	64,719	14	--	--
Total 3/	110	74,112	100.0	9,035	351	1288	86,235	672,345	277	68	835,179

r/ Revised.
1/ Includes portland and masonry cement. Excludes grinding plants.
2/ Includes Puerto Rico.
3/ Data may not add to totals shown because of independent rounding.

TABLE 7
ELECTRIC ENERGY USED AT CEMENT PLANTS
IN THE UNITED STATES, BY PROCESS 1/

Plant process	Electric energy used: Generated at plant, Number of plants	Generated at plant, Quantity (million kilowatt-hours)	Purchased, Number of plants	Purchased, Quantity (million kilowatt-hours)	Total, Quantity (million kilowatt-hours)	Total, Percentage	Finished cement 2/ produced (thousand metric tons)	Average consumption (kilowatt-hours per ton of cement produced)
1996:								
Integrated plants								
Wet	--	--	35 r/	2,806 r/	2,806 r/	24.4 r/	20,520 r/	137
Dry	4	500	74 r/	7,969 r/	8,469 r/	73.6 r/	56,516 r/	150
Both	--	--	2 r/	231 r/	231 r/	2.0 r/	1,534 r/	151
Total 3/	4	500	111 r/	11,006 r/	11,506 r/	100.0	78,571 r/	146 r/
Grinding plants 4/	--	--	5	135	135	--	2,081	65
Exclusions 5/	--	--	2	--	--	--	57	--
1997:								
Integrated plants								
Wet	--	--	35	2,867	2,867	24.2	21,706	132
Dry	4	493	73	8,226	8,719	73.7	58,481	149
Both	--	--	2	246	246	2.1	1,642	150
Total 3/	4	493	110	11,340	11,833	100.0	81,829	145
Grinding plants 4/	--	--	6	151	151	--	2,211	68
Exclusions 5/	--	--	2	--	--	--	68	--

r/ Revised.

1/ Includes Puerto Rico.

2/ Includes portland and masonry cement. Excludes portland cement consumed in the production of masonry cement.

3/ Data may not add to totals shown because of independent rounding.

4/ Excludes plants that reported production only of masonry cement.

5/ Tonnage of cement produced by plants that reported production only of masonry cement.

TABLE 8
CEMENT SHIPMENTS TO FINAL CUSTOMER, BY DESTINATION AND ORIGIN 1/ 2/

(Thousand metric tons)

Destination and origin	Portland cement		Masonry cement	
	1996	1997	1996	1997
Destination:				
Alabama	1,474	1,425	133	137
Alaska	100	107	W	W
Arizona	2,517 r/	2,563	W	W
Arkansas	905	1,009	56	54
California, northern	3,215 r/	3,587	14 r/	13
California, southern	5,166 r/	5,883	W	W
Colorado	1,891	2,013	21	25
Connecticut 3/	654	690	12	13
Delaware 3/	240	247	9	10
District of Columbia 3/	115	105	1	1
Florida	6,082	6,435	538	536
Georgia	3,179	3,225	233	237
Hawaii	313	251	5	3
Idaho	449	473	1	1
Illinois, excluding Chicago	1,538	1,525	35	33
Chicago, metropolitan 3/	1,943	1,995	43	49
Indiana	1,947	2,140	93	96
Iowa	1,601	1,739	12	12
Kansas	1,527	1,508	16	15
Kentucky	1,258	1,328	93	98
Louisiana 3/	1,751	1,820	53	50
Maine	212	187	5	5
Maryland	1,179	1,225	73	80
Massachusetts 3/	1,074	1,262	24	24
Michigan	2,992	3,201	143	153
Minnesota 3/	1,605	1,693	32	30
Mississippi	931	968	56	53
Missouri	2,269	2,311	41	40
Montana	273	303	1	1
Nebraska	994	1,020	10	10
Nevada	1,784 r/	1,899	19 r/	15
New Hampshire 3/	275	263	7	7
New Jersey 3/	1,471	1,700	61	63
New Mexico	747	739	8	7
New York, eastern	484	518	21	23
New York, western	759	879	31	35
New York, metropolitan 3/	1,203	1,291	42	46
North Carolina 3/	2,259	2,599	273	296
North Dakota 3/	322 r/	266	13 r/	4
Ohio	3,725	3,774	190	197
Oklahoma	1,145	1,188	41	43
Oregon	1,165	1,195	(4/)	1
Pennsylvania, eastern	1,840	1,958	60	63
Pennsylvania, western	1,035	1,124	68	70
Rhode Island 3/	111	127	3	3
South Carolina	1,160	1,200	116	125
South Dakota	333	420	4	3
Tennessee	1,965	2,041	211	211
Texas, northern	4,373	4,543	162	150
Texas, southern	4,413	4,834	90	81
Utah	1,267	1,354	3	1
Vermont 3/	111	106	3	3
Virginia	1,794	1,910	149	157
Washington	1,722	1,862	6	5
West Virginia	443	440	29	30
Wisconsin	2,013	2,129	38	37
Wyoming	196	228	1	1
U.S. total 5/ 6/	87,509 r/	92,824	3,569 r/	3,627
Foreign countries 7/	355	349	4 r/	1
Puerto Rico	1,555	1,670	--	--
Total shipments 5/	89,419 r/	94,843	3,573 r/	3,628

See footnotes at end of table.

TABLE 8-Continued
CEMENT SHIPMENTS TO FINAL CUSTOMER, BY DESTINATION AND ORIGIN 1/ 2/

(Thousand metric tons)

Destination and origin	Portland cement		Masonry cement	
	1996	1997	1996	1997
Origin:				
United States	76,356 r/	79,403	3,534 r/	3,583
Puerto Rico	1,555	1,670	--	--
Foreign countries 8/	11,508 r/	13,769	39 r/	45
Total shipments 5/	89,419 r/	94,843	3,573 r/	3,628

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "U.S. total."
1/ Includes cement produced from imported clinker and imported cement shipped by domestic producers, Canadian cement manufacturers, and other importers.
2/ Data are developed from monthly consolidated surveys of shipments by company and may differ from data in tables 1, 10, 11, 12, 14, and 15, which are from annual surveys of individual plants and importers.
3/ Has no cement plants.
4/ Less than 1/2 unit.
5/ Data may not add to totals shown because of independent rounding.
6/ Includes States indicated by the symbol W.
7/ Includes shipments to U.S. possessions and territories.
8/ Imported cement distributed in the United States by domestic producers, Canadian cement manufacturers, and other importers.

TABLE 9
CEMENT SHIPMENTS, BY DESTINATION (REGION AND CENSUS DISTRICT) 1/ 2/

Region and census district	Portland cement				Masonry cement			
	Thousand metric tons		Percentage of U.S. total		Thousand metric tons		Percentage of U.S. total	
	1996	1997	1996	1997	1996	1997	1996	1997
Northeast:								
New England 3/	2,438	2,634	3	3	54	55	2	2
Middle Atlantic 4/	6,792	7,469	8	8	282	301	8	8
Total 5/	9,230	10,103	11	11	337 r/	356	9 r/	10
South:								
South Atlantic 6/	16,452	17,386	19	19	1,421	1,472	40 r/	41
East South Central 7/	5,627	5,762	6	6	493	498	14	14
West South Central 8/	12,587	13,394	14 r/	14	402	378	11 r/	10
Total 5/	34,666	36,541	40 r/	39	2,316	2,349	65 r/	65
Midwest:								
East North Central 9/	14,159	14,765	16	16	541	566	15 r/	16
West North Central 10/	8,650 r/	8,958	10	10	127 r/	114	4	3
Total 5/	22,809 r/	23,722	26	26	668 r/	680	19 r/	19
West:								
Mountain 11/	9,123 r/	9,572	10	10	149 r/	140	4 r/	4
Pacific 12/	11,682 r/	12,886	13 r/	14	99 r/	102	3 r/	3
Total 5/	20,805 r/	22,457	24	24	248 r/	242	7 r/	7
U.S. total 5/	87,509 r/	92,824	100	100	3,569 r/	3,627	100	100

r/ Revised.

1/ Includes imported cement shipped by importers. Excludes Puerto Rico and exported cement.

2/ Data are developed from monthly consolidated surveys of shipments by company and may differ from data in tables 1, 10, 11, 12, 14, and 15, which are from annual surveys of individual plants and importers.

3/ New England includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

4/ Middle Atlantic includes New Jersey, New York, and Pennsylvania.

5/ Data may not add to totals shown because of independent rounding.

6/ South Atlantic includes Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia.

7/ East South Central includes Alabama, Kentucky, Mississippi, and Tennessee.

8/ West South Central includes Arkansas, Louisiana, Oklahoma, and Texas.

9/ East North Central includes Illinois, Indiana, Michigan, Ohio, and Wisconsin.

10/ West North Central includes Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota.

11/ Mountain includes Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.

12/ Pacific includes Alaska, California, Hawaii, Oregon, and Washington.

TABLE 10
SHIPMENTS OF PORTLAND CEMENT FROM MILLS IN THE UNITED STATES, IN BULK AND IN CONTAINERS, BY TYPE OF CARRIER 1/

(Thousand metric tons)

	Shipments from plant to terminal		Shipments to final domestic consumer				
			From plant to consumer		From terminal to consumer		Total
	In bulk	In containers 2/	In bulk	In containers 2/	In bulk	In containers 2/	shipments to consumer 3/ 4/
1996:							
Railroad	10,527	54	5,036	433	520	53	6,042
Truck	3,143	147	43,986 r/	1,708	27,679 r/	870	74,243 r/
Barge and boat	7,021	--	565	3	810	--	1,378
Other 5/	1,810 r/	--	--	--	14	2	16
Total 3/	22,502	201	49,588 r/	2,144	29,023 r/	927	81,681 r/
1997:							
Railroad	11,221	56	4,390	416	1,436	61	6,304
Truck	3,635	99	47,552	2,042	31,739	576	81,908
Barge and boat	8,270	--	146	--	11	--	156
Other 5/	1,929	--	--	--	--	--	--
Total 3/	25,055	156	52,088	2,458	33,186	637	88,368

r/ Revised.
1/ Includes Puerto Rico. Includes imported cement and cement made from foreign clinker.
2/ Includes bags and jumbo bags.
3/ Data may not add to totals shown because of independent rounding.
4/ Shipments calculated based on annual survey of plants and importers; may differ from tables 8 and 9, which are based on consolidated company monthly data.
5/ Includes cement used at plant.

TABLE 11
PORTLAND CEMENT SHIPPED BY PRODUCERS IN THE UNITED STATES, BY DISTRICT 1/ 2/ 3/

District	1996 Quantity (thousand metric tons) 5/	1996 Value 4/ Total (thousands)	1996 Value 4/ Average per ton	1997 Quantity (thousand metric tons) 5/	1997 Value 4/ Total (thousands)	1997 Value 4/ Average per ton
Maine and New York	1,770 r/	$107,613 r/	$60.79 r/	1,826	$115,365	$63.19
Pennsylvania, eastern	4,095	307,830	75.17	4,454	283,965	63.75
Pennsylvania, western	1,612	112,747	69.94	1,689	121,649	72.04
Illinois	2,653	183,736	69.26	2,590	186,281	71.91
Indiana	2,570	168,032	65.38	2,663	187,076	70.24
Michigan	5,470	403,465	73.76	5,739	425,705	74.18
Ohio	1,013	74,100	73.15	1,107	81,655	73.75
Iowa, Nebraska, South Dakota	3,966	291,842 r/	73.59 r/	4,247	323,321	76.12
Kansas	1,859	128,848	69.31	1,798	129,970	72.28
Missouri	5,141	332,715	64.72	5,563	377,411	67.84
Florida	4,575	325,302	71.10	4,750	346,945	73.04
Georgia, Virginia, West Virginia	2,644	193,907	73.34	2,773	212,006	76.45
Maryland	1,924	118,832	61.76	2,064	132,049	63.98
South Carolina	2,463	193,115	78.41	2,531	194,938	77.02
Alabama	4,138	311,819	75.36	4,103	329,663	80.34
Kentucky, Mississippi, Tennessee	2,712	197,788	72.93	2,911	216,284	74.31
Arkansas and Oklahoma	2,545	170,721	67.08	2,673	185,509	69.40
Texas, northern	3,562	242,030	67.95	4,028	299,071	74.25
Texas, southern	5,152	320,441	62.20	5,141	338,549	65.86
Arizona and New Mexico	2,238	172,938	77.27	2,313	189,424	81.90
Colorado, Wyoming	2,001	160,521	80.22	2,056	163,640	79.60
Idaho, Montana, Nevada, Utah	2,398	190,588	79.48	2,646	213,531	80.71
Alaska, Hawaii, Oregon, Washington	1,493	125,137	83.79	2,292	193,545	84.46
California, northern	2,151	147,089	68.38	2,425	180,158	74.28
California, southern	6,897	415,781	60.28	7,521	503,632	66.96
Total 6/ 7/ 8/ or average	80,130 r/	5,629,371 r/	70.25 r/	86,692	6,293,261	72.59
Puerto Rico	1,555	W	W	1,677	W	W

r/ Revised. W Withheld to avoid disclosing company proprietary data.

1/ Includes cement produced from imported clinker.

2/ Includes imported cement shipped by producers.

3/ Includes data for three white cement facilities as follows: California, Pennsylvania, and Texas.

4/ Values represent ex-plant (f.o.b -plant) data collected for total shipments to final customers, not for shipments by cement type. Although presented unrounded, the data incorporate estimates for some plants. Accordingly, the data should be viewed as cement value indicators, good to no better than the nearest $0.50 or even $1.00.

5/ Shipments calculated based on annual survey of plants and importers; may differ from tables 8 and 9, which are based on consolidated company monthly data.

6/ Data may not add to totals shown because of independent rounding.

7/ Does not include cement consumed at plant.

8/ Total includes imports shipped by independent importers.

TABLE 12
MASONRY CEMENT SHIPPED BY PRODUCERS IN THE UNITED STATES, BY DISTRICT 1/ 2/ 3/

District	1996 Quantity (thousand metric tons) 5/	1996 Value 4/ Total (thousands)	1996 Value 4/ Average per ton	1997 Quantity (thousand metric tons) 5/	1997 Value 4/ Total (thousands)	1997 Value 4/ Average per ton
Maine and New York	102	$8,440	$83.10 r/	107	$9,348	$87.15
Pennsylvania, eastern	181	17,783	98.07 r/	203	20,408	100.30
Pennsylvania, western	99	10,861	109.18 r/	104	11,829	113.92
Illinois, Indiana, Ohio	451 r/	42,756	94.72 r/	498	48,415	97.31
Michigan	254	22,271	87.68	283	23,248	82.17
Iowa, Nebraska, South Dakota	46	5,075	110.60 r/	43	3,644	84.76
Kansas and Missouri	141 r/	8,691	61.77 r/	144	9,387	65.08
Florida	418	34,901	83.50	387	34,556	89.29
Georgia, Virginia, West Virginia	366	40,174	109.77	410	39,009	95.07
Maryland and South Carolina	363 r/	34,901	96.12 r/	424	44,470	104.82
Alabama	311	32,240	103.67	314	32,847	104.44
Kentucky, Mississippi, Tennessee	113	10,391	91.96	97	8,254	85.35
Arkansas and Oklahoma	110	9,487	86.33 r/	108	7,965	73.97
Texas	195 r/	18,289	93.89	184	17,081	93.08
Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah, Wyoming	122 r/	11,186	91.59 r/	130	11,751	90.64
Alaska and Hawaii	4	454	102.41 r/	3	354	102.32
California, Oregon, Washington	198 r/	14,729	74.30 r/	175	14,119	80.66
Total 6/ 7/ or average	3,477	322,832	92.85	3,667	344,203	93.87

r/ Revised.
1/ Shipments are to final domestic customers and include shipments of imported cement.
2/ Includes data for three white cement facilities as follows: California, Pennsylvania, and Texas.
3/ Excludes Puerto Rico (did not produce any masonry cement).
4/ Values are mill net and represent ex-plant (f.o.b. - plant or import terminal) data collected for total shipments to final customers, not for shipments by cement type. Although presented unrounded, the data incorporate estimated for some plants. Accordingly, the data should be viewed as cement-value indicators, good to no better than the nearest $0.50 or even $1.00.
5/ Shipments calculated on the basis of annual survey of plants and importers; may differ from tables 8 and 9, which are based on consolidated company monthly data.
6/ Data may not add to totals shown because of independent rounding.
7/ Total includes imports shipped by independent importers.

TABLE 13
AVERAGE MILL NET VALUE OF CEMENT IN THE UNITED STATES 1/ 2/

(Dollars per metric ton)

Year	Gray portland cement	White portland cement	All portland cement	Prepared masonry cement	All classes of cement
1996 r/	69.38	183.1	70.25	92.85	71.19
1997	71.85	177.1	72.59	93.87	73.49

r/ Revised.
1/ Excludes Puerto Rico. Mill net value is the actual value of sales to customers, f.o.b. plant or import terminal, less all discounts and allowances, less any freight charges from U.S. producing plant to distribution terminal and to final customers.
2/ Although unrounded, the data incorporate estimates for some plants, and are good to no better than two significant figures.

TABLE 14
PORTLAND CEMENT SHIPMENTS IN 1997, BY DISTRICT AND TYPE OF CUSTOMER 1/ 2/

(Thousand metric tons)

District	Ready mixed concrete	Concrete product manufacturers 3/	Contractors 4/	Building material dealers	Oil well, mining, waste 5/	Government and miscellaneous 6/	District total 7/ 8/
Maine and New York	1,309	278	149	85	(9/)	3	1,826
Pennsylvania, eastern	2,927	853	365	209	45	56	4,454
Pennsylvania, western	617	232	389	277	23	151	1,689
Illinois	1,756	329	108	157	242	--	2,590
Indiana	2,154	382	28	81	11	9	2,663
Michigan	4,399	600	637	62	21	19	5,739
Ohio	755	171	157	15	7	2	1,107
Iowa, Nebraska, South Dakota	3,082	570	353	89	63	91	4,247
Kansas	1,330	195	221	24	23	7	1,798
Missouri	4,189	545	611	163	--	53	5,563
Florida	3,319	732	251	372	22	52	4,750
Georgia, Virginia, West Virginia	2,145	386	143	88	12	--	2,773
Maryland	1,507	313	230	14	--	(9/)	2,064
South Carolina	1,886	432	86	69	48	10	2,531
Alabama	3,050	629	192	197	24	11	4,103
Kentucky, Mississippi, Tennessee	2,326	217	318	25	4	22	2,911
Arkansas and Oklahoma	1,933	201	414	30	94	2	2,673
Texas, northern	2,274	425	699	169	442	19	4,028
Texas, southern	3,487	286	751	145	280	191	5,141
Arizona and New Mexico	1,635	320	138	70	38	113	2,313
Colorado and Wyoming	1,180	183	87	55	550	--	2,056
Idaho, Montana, Nevada, Utah	2,113	201	132	30	59	110	2,646
Alaska and Hawaii	258	19	6	17	(9/)	6	305
California, northern	1,832	346	113	100	--	34	2,425
California, southern	5,704	1,100	341	242	106	28	7,521
Oregon and Washington	1,559	141	199	74	1	12	1,986
Total 8/ 10/	62,591	10,639	7,246	3,022	2,164	1,030	86,692
Puerto Rico	853	172	50	600	--	2	1,677

1/ Includes shipments of imported cement. Data, other than district totals, are presented unrounded but incorporate estimates for some plants and are likely accurate to only two significant figures.
2/ Previously referred to as District of origin, but in fact refers only to the location of the reporting facility.
3/ Shipments to concrete product manufacturers include brick-block--4,062; precast--2,341; pipe--1,486; and other or unspecified--2,922.
4/ Shipments to contractors include airport--508; road paving--4,017; soil cement--1,641 and other or unspecified--1,130.
5/ Shipments to oil well, mining, and waste include oil well drilling--1,377; mining--621; and waste stabilization--206.
6/ Includes shipments for which customer types were not specified.
7/ Shipments calculated on the basis of annual survey of plants and importers; may differ from tables 8 and 9, which are based on consolidated monthly data.
8/ Data may not add to totals shown because of independent rounding.
9/ Less than 1/2 unit.
10/ Includes imports shipped by independent importers.

TABLE 15
PORTLAND CEMENT SHIPPED FROM PLANTS IN THE
UNITED STATES TO DOMESTIC CUSTOMERS, BY TYPE 1/ 2/

(Thousand metric tons)

Type	1996	1997
General use and moderate heat (Types I and II), (Gray)	73,666 r/	79,312
High early strength (Type III)	2,942	3,109
Sulfate resisting (Type V)	2,000	2,456
Block	416	506
Oil well	1,041	1,229
White	615	634
Blended:		
Portland-slag and portland (natural) pozzolan	770	639
Other blended cement 3/	63	314
Expansive and regulated fast setting	81	120
Miscellaneous 4/	89	50
Total 5/	81,685 r/	88,368

r/ Revised.
1/ Includes imported cement. Includes Puerto Rico.
2/ Shipments calculated based on annual survey of plants and importers; may differ from tables 8 and 9, which are based on consolidated company monthly data.
3/ Includes blends with fly ash and silica fume.
4/ Includes waterproof and low heat (Type IV).
5/ Data may not add to totals shown because of independent rounding.

TABLE 16
U.S. EXPORTS OF HYDRAULIC CEMENT AND CLINKER, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

	1996		1997	
Country of destination	Quantity	Value 2/	Quantity	Value 2/
Australia	4	247	5	402
Bahamas, The	5	538	8	858
British Virgin Islands	5	296	6	516
Canada	611	42,193	605	42,106
Chile	--	19	10	542
Germany	22	1,814	23	963
Latvia	--	--	8	355
Mexico	30	4,805	45	5,997
Panama	1	233	7	623
Russia	1	78	6	298
Other	124 r/	7,929 r/	66	6,951
Total 3/	803	58,152	791	59,611

r/ Revised.
1/ Includes portland and masonry cement.
2/ Free alongside ship (f.a.s.) value. The value of exports at the U.S. seaport or border port of export based on the transaction price, including inland freight, insurance, and other charges incurred in placing the merchandise alongside the carrier at the U.S. port of exportation. The value excludes the cost of loading.
3/ Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

TABLE 17
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country of origin	1996			1997		
		Value			Value	
	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Bulgaria	148	4,433	6,274	146	4,086	5,987
Canada	5,351	246,694	270,198	5,350	269,471	293,868
China	394	15,771	19,714	610	24,951	32,196
Colombia	924	36,520	46,872	906	36,898	47,177
Denmark	399	17,593	26,393	579	24,576	34,993
France	55	9,783	10,944	441	27,157	31,471
Greece	1,098	40,803	52,046	1,860	68,741	88,620
Italy	209	8,432	11,751	401	17,041	21,876
Mexico	1,272	47,736	59,390	995	37,804	47,612
Norway	226	8,181	11,032	283	10,182	12,906
Spain	1,595	63,274	83,739	1,845	75,282	100,988
Sweden	765	24,337	33,495	886	28,620	38,437
Turkey	68	2,471	3,187	973	35,805	46,111
United Kingdom	64	2,631	2,911	153	7,289	8,700
Venezuela	1,517	58,424	73,536	1,994	76,189	95,503
Other	69 r/	5,166 r/	7,074 r/	174	7,975	10,884
Total 4/	14,154	592,249	718,556	17,596	752,067	917,329

r/ Revised.

1/ Includes portland, masonry, and other hydraulic cements. Includes Puerto Rico.

2/ Customs value. The price actually paid or payable for merchandise when sold for exportation to the United States, excluding U.S. import duties, freight, insurance, and other charges incurred in bringing the merchandise to the United States.

3/ C.i.f. (Cost, insurance, and freight). The import value represents the customs value plus insurance, freight, and other delivery charges to the first port of entry.

4/ Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

TABLE 18
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

Customs district and country	1996			1997		
		Value			Value	
	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
Anchorage:						
Canada	5	138	309	7	265	286
China	59	2,413	3,443	64	2,555	3,602
Japan	--	--	--	(4/)	5	5
Total 3/	64	2,551	3,752	71	2,825	3,892
Baltimore:						
China	--	--	--	(4/)	2	4
Greece	38	1,447	1,643	--	--	--
Spain	15	551	551	--	--	--
United Kingdom	(4/)	18	27	--	--	--
Venezuela	131	5,421	5,421	169	7,001	7,001
Total 3/	184	7,437	7,642	169	7,004	7,005
Boston:						
Canada	--	--	--	9	258	262
Netherlands	--	--	--	(4/)	13	14
Turkey	--	--	--	11	386	574
Total 3/	(4/)	--	--	20	656	850
Buffalo:						
Canada	740	37,270	39,996	836	47,226	50,125
Netherlands	--	--	--	(4/)	28	28
Total 3/	741 r/	37,270	39,996	836	47,254	50,154
Charleston:						
Canada	--	--	--	19	653	942
France	--	--	--	(4/)	3	5
Netherlands	(4/)	19	20	(4/)	33	36
Spain	(4/)	36	39	--	--	--
Sweden	--	--	--	12	664	785
Turkey	--	--	--	15	541	815
United Kingdom	(4/)	91	126	(4/)	59	83
Venezuela	66	2,689	3,639	80	3,244	4,399
Total 3/	66 r/	2,835	3,824	125	5,197	7,065
Chicago:						
Japan	(4/)	59	69	(4/)	20	22
United Kingdom	--	--	--	(4/)	3	4
Total 3/	(4/)	59	69	(4/)	23	26
Cleveland:						
Canada	497	25,320	26,051	628	35,817	36,622
Netherlands	(4/)	12	15	(4/)	94	111
United Kingdom	(4/)	13	16	(4/)	93	122
Total 3/	497	25,345	26,081	628	36,003	36,854
Columbia Snake:						
China	335	13,330	16,238	367	14,735	19,014
Colombia	18	685	867	54	2,189	2,997
Taiwan	--	--	--	10	435	546
Total 3/	353	14,015	17,105	432	17,360	22,556
Dallas-Fort Worth: United Kingdom	(4/)	6	7	--	--	--
Detroit:						
Canada	1,647	79,423	84,419	1,664	86,466	95,989
Germany	--	--	--	(4/)	2	2
Netherlands	(4/)	135	162	(4/)	86	101
United Kingdom	--	--	--	25	761	771
Total 3/	1,647	79,559	84,581	1,689	87,315	96,863
Duluth: Canada	332	13,559	15,562	345	13,468	15,485
El Paso:						
China	--	--	--	(4/)	2	2
Mexico	467	14,980	20,287	455	15,214	19,978
Total 3/	467	14,980	20,287	455	15,215	19,979

See footnotes at end of table.

TABLE 18--Continued
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

Customs district and country	1996			1997		
		Value			Value	
	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
Great Falls:						
Canada	274	11,548	13,435	222	9,404	10,730
Japan	(4/)	2	6	(4/)	2	3
United Kingdom	(4/)	16	25	--	--	--
Total 3/	274 r/	11,566	13,465	223	9,406	10,734
Honolulu:						
Australia	42	1,499	2,141	83	2,692	4,013
Belgium	(4/)	15	19	--	--	--
France	(4/)	21	26	--	--	--
Venezuela	115	3,491	5,792	180	5,433	9,063
Total 3/	157	5,027	7,977	263	8,125	13,076
Houston-Galveston:						
Colombia	46	1,739	2,729	51	1,891	2,942
Denmark	30	1,067	1,438	192	6,818	9,134
France	(4/)	83	99	3	373	487
Greece	--	--	--	217	7,874	10,206
Japan	(4/)	46	55	(4/)	74	87
Spain	675	24,872	32,188	520	20,429	25,445
Turkey	--	--	--	32	1,696	2,176
United Kingdom	(4/)	41	55	(4/)	20	26
Venezuela	27	899	1,120	--	--	--
Total 3/	780	28,748	37,684	1,015	39,174	50,504
Laredo: Mexico	69 r/	7,121	7,590	70	7,060	7,630
Los Angeles:						
China	--	--	--	170	7,036	8,818
Colombia	--	--	--	32	1,284	1,757
Denmark	(4/)	3	5	--	--	--
France	--	--	--	62	3,261	3,329
Mexico	382	13,945	17,027	19	693	846
Spain	--	--	--	693	26,177	38,761
Turkey	--	--	--	32	1,704	1,722
United Kingdom	--	--	--	(4/)	14	24
Total 3/	382	13,948	17,031	1,007	40,169	55,257
Miami:						
Belgium	2	251	340	2	388	422
Canada	24	871	1,153	--	--	--
Denmark	44	1,942	3,290	8	476	857
Greece	--	--	--	14	488	631
Italy	--	--	--	(4/)	2	3
Portugal	(4/)	23	24	--	--	--
Spain	435	19,166	27,430	513	24,058	30,236
Sweden	441	13,529	18,471	497	15,349	20,183
Turkey	--	--	--	16	515	694
United Kingdom	(4/)	1	1	--	--	--
Venezuela	189	7,439	9,913	204	7,874	10,517
Total 3/	1,135 r/	43,223	60,622	1,254	49,150	63,543
Milwaukee: Canada	219	9,069	10,279	171	7,863	9,763
Minneapolis: Germany	(4/)	12	13	(4/)	9	10
Mobile:						
Belgium	--	--	--	52	1,764	2,230
Bulgaria	122	3,368	4,863	55	1,548	2,234
Canada	163	5,087	6,948	--	--	--
France	--	--	--	51	1,623	2,080
Greece	73	2,446	3,317	--	--	--
Venezuela	25	819	1,007	115	4,181	5,123
Total 3/	383	11,721	16,135	273	9,115	11,667

See footnotes at end of table.

TABLE 18--Continued
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

Customs district and country	1996			1997		
		Value			Value	
	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
New Orleans:						
Austria	(4/)	6	8	--	--	--
Canada	88	3,065	4,047	--	--	--
China	(4/)	28	33	4	389	466
Colombia	120	5,131	6,768	--	--	--
Croatia	5	605	873	5	585	801
France	10	1,576	1,906	80	4,269	5,326
Greece	282	10,601	13,993	578	21,013	27,975
Italy	208	8,431	11,745	374	15,966	20,519
Spain	9	340	438	18	717	885
Sweden	236	7,837	10,906	369	12,269	17,063
Turkey	34	1,271	1,592	303	11,275	14,865
Venezuela	--	--	--	34	1,286	1,582
Total 3/	993	38,889	52,309	1,764	67,769	89,483
New York City:						
Belgium	--	--	--	(4/)	21	22
Denmark	--	--	--	55	2,814	3,097
Greece	206	7,455	8,215	357	13,331	15,777
Italy	(4/)	1	6	27	1,073	1,354
Japan	(4/)	7	7	--	--	--
Netherlands	(4/)	226	241	(4/)	195	207
Norway	226	8,181	11,032	283	10,182	12,906
Spain	236	10,465	13,136	--	--	--
Tunisia	--	--	--	(4/)	12	18
Turkey	--	--	--	258	8,932	10,498
United Kingdom	--	--	--	(4/)	12	16
Venezuela	--	--	--	21	738	902
Total 3/	667 r/	26,335	32,637	1,001	37,309	44,797
Nogales: Mexico	350 r/	11,189	13,944	439	13,342	17,446
Norfolk:						
Croatia	--	--	--	(4/)	2	4
Denmark	214	8,460	11,079	223	8,162	10,871
France	45	8,103	8,914	59	11,598	12,610
Greece	438	16,756	22,029	513	19,795	25,641
Netherlands	(4/)	87	97	--	--	--
South Africa, Republic of	--	--	--	(4/)	9	11
United Kingdom	(4/)	124	173	2	564	760
Venezuela	5	208	213	20	834	1,110
Total 3/	703	33,737	42,504	817	40,964	51,008
Ogdensburg:						
Canada	260	8,789	9,679	334	12,814	14,361
Netherlands	(4/)	56	69	--	--	--
Total 3/	260 r/	8,845	9,748	334	12,814	14,361
Pembina: Canada	143	6,812	7,724	186	8,650	9,910
Philadelphia:						
Germany	(4/)	23	23	--	--	--
Japan	(4/)	12	15	--	--	--
United Kingdom	(4/)	10	22	--	--	--
Total 3/	(4/)	44	60	--	--	--
Portland: Canada	10	478	581	15	828	910
Providence:						
Canada	--	--	--	26	733	770
Spain	--	--	--	82	3,072	4,669
Total 3/	(4/)	(4/)	1	108	3,806	5,440
San Diego: Mexico	4	501	542	9	1,200	1,366
San Francisco:						
France	--	--	--	(4/)	15	21
Germany	(4/)	11	15	--	--	--

See footnotes at end of table.

TABLE 18--Continued
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

Customs district and country	1996			1997		
		Value			Value	
	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
San Francisco--Continued:						
Japan	(4/)	49	63	--	--	--
New Zealand	1	703	852	--	--	--
United Kingdom	--	--	--	(4/)	19	23
Venezuela	--	--	--	29	874	880
Total 3/	1	764	929	29	908	924
San Juan:						
Belgium	4	341	583	7	609	1,049
Canada	--	--	--	(4/)	2	3
Denmark	16	1,314	2,293	20	1,557	2,783
Luxembourg	5	439	764	1	63	110
Mexico	--	--	--	3	294	345
Spain	119	4,044	4,863	6	385	408
Turkey	--	--	--	8	376	572
Venezuela	43	1,890	2,332	161	5,854	6,744
Total 3/	187 r/	8,029	10,836	206	9,140	12,014
Savannah:						
Bulgaria	26	1,064	1,410	91	2,538	3,753
Canada	78	2,389	3,335	--	--	--
Colombia	19	1,027	1,181	56	3,034	3,489
Denmark	13	852	1,420	(4/)	10	10
France	--	--	--	187	6,014	7,615
United Kingdom	64	2,310	2,460	126	5,730	6,853
Venezuela	106	3,801	5,134	114	4,025	5,004
Total 3/	307	11,443	14,939	574	21,351	26,724
Seattle:						
Canada	744	36,518	38,962	796	39,810	42,125
China	--	--	--	5	232	292
Colombia	198	7,769	11,244	191	7,770	11,046
Japan	(4/)	20	24	(4/)	128	156
Taiwan	--	--	--	12	522	642
Total 3/	942	44,307	50,230	1,005	48,462	54,261
St. Albans:						
Canada	99	5,327	6,271	90	5,215	5,583
Netherlands	(4/)	123	143	(4/)	136	152
Total 3/	99 r/	5,450	6,413	90	5,351	5,735
Tampa:						
Canada	27	1,032	1,445	--	--	--
Colombia	520	20,019	23,916	522	20,731	24,946
Denmark	83	3,955	6,870	80	4,739	8,240
Greece	61	2,099	2,849	181	6,240	8,389
Spain	105	3,800	5,095	12	443	584
Sweden	88	2,970	4,118	9	338	406
Turkey	34	1,201	1,595	298	10,381	14,196
Venezuela	751	29,388	36,197	741	29,908	36,897
Total 3/	1,669	64,463	82,086	1,844	72,780	93,659
U.S. Virgin Islands:						
Antigua and Barbuda	--	--	--	(4/)	20	41
British Virgin Islands	1	98	118	2	5	10
Colombia	3	150	167	--	--	--
Costa Rica	--	--	--	(4/)	2	2
Netherlands Antilles	5	167	183	--	--	--
Trinidad and Tobago	3	114	119	--	--	--
Venezuela	59	2,378	2,769	65	2,543	3,026
Total 3/	70	2,907	3,356	67	2,571	3,080
Wilmington:						
Netherlands	(4/)	6	12	(4/)	24	26
United Kingdom	--	--	--	(4/)	16	20

See footnotes at end of table.

TABLE 18--Continued
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

Customs district and country	1996			1997		
		Value			Value	
	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
Wilmington--Continued:						
Venezuela	--	--	--	59	2,393	3,253
Total 3/	(4/)	6	12	59	2,433	3,300
Grand total 3/	14,154	592,249	718,556	17,596	752,067	917,329

r/ Revised.
1/ Customs value. The price actually paid or payable for merchandise when sold for exportation to the United States, excluding U.S. import duties, freight, insurance, and other charges incurred in bringing the merchandise to the United States.
2/ C.i.f. (Cost, insurance, and freight). The import value represents the customs value plus insurance, freight, and other delivery charges to the first port of entry. It is computed by adding "freight" to the "customs value."
3/ Data may not add to totals shown because of independent rounding.
4/ Less than 1/2 unit.

Source: U.S. Bureau of the Census.

TABLE 19
U.S. IMPORTS FOR CONSUMPTION OF GRAY PORTLAND CEMENT, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1996			1997		
		Value			Value	
	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Canada	3,953	182,457	198,857	4,086	202,335	218,025
China	393	15,743	19,682	606	24,560	31,726
Colombia	685	27,734	35,737	734	30,580	39,409
Denmark	303	11,803	16,000	467	17,175	22,614
France	(4/)	5	13	133	6,075	6,978
Greece	983	36,949	46,822	1,672	61,789	79,495
Italy	208	8,432	11,751	344	14,802	19,060
Mexico	1,178	37,470	48,367	885	25,945	34,707
Norway	218	7,410	10,176	276	9,407	12,051
Spain	1,428	53,769	72,737	1,782	67,773	92,586
Sweden	765	24,337	33,495	887	28,620	38,437
Turkey	68	2,471	3,187	827	31,037	39,751
United Kingdom	34	1,502	1,651	63	2,891	3,893
Venezuela	944	38,556	46,530	1,214	49,452	60,631
Other	7 r/	309 r/	335 r/	23	998	1,240
Total 5/	11,167	448,947	545,340	13,999	573,439	700,603

r/ Revised.
1/ Includes imports into Puerto Rico.
2/ Customs value. The price actually paid or payable for merchandise when sold for exportation to the United States, excluding U.S. import duties, freight, insurance, and other charges incurred in bringing the merchandise to the United States.
3/ C.i.f. (Cost, insurance, and freight). The import value represents the customs value plus insurance, freight, and other delivery charges to the first port of entry.
4/ Less than 1/2 unit.
5/ Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

TABLE 20
U.S. IMPORTS FOR CONSUMPTION OF WHITE CEMENT, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1996			1997		
		Value			Value	
	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Belgium	6	591	923	9	998	1,473
Canada	135	12,170	12,700	215	16,858	18,024
Denmark	96	5,787	10,389	113	7,391	12,368
Luxembourg	6	439	764	1	63	110
Mexico	91	9,995	10,732	108	11,718	12,754
Norway	8	771	856	8	776	854
Spain	48	5,425	6,101	63	7,509	8,402
United Kingdom	--	--	--	4	197	284
Other	(4/)	228	244	(4/)	197	212
Total 5/	390	35,406	42,709	520	45,707	54,480

1/ Includes imports into Puerto Rico.
2/ Customs value. The price actually paid or payable for merchandise when sold for exportation to the United States, excluding U.S. import duties, freight, insurance, and other charges incurred in bringing the merchandise to the United States.
3/ C.i.f. (Cost, insurance, and freight). The import value represents the customs value plus insurance, freight, and other delivery charges to the first port of entry.
4/ Less than 1/2 unit.
5/ Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

TABLE 21
U.S. IMPORTS FOR CONSUMPTION OF CLINKER, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1996			1997		
		Value			Value	
	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Australia	42	1,499	2,141	83	2,692	4,013
Belgium	--	--	--	52	1,764	2,230
Bulgaria	148	4,433	6,274	146	4,086	5,987
Canada	1,253	50,345	56,695	1,019	45,601	52,877
Colombia	239	8,785	11,135	173	6,318	7,768
France	53	8,065	9,039	304	18,721	21,932
Greece	115	3,854	5,224	181	6,240	8,389
Italy	--	--	--	57	2,239	2,816
Spain	119	4,044	4,863	--	--	--
Turkey	--	--	--	145	4,768	6,360
United Kingdom	--	--	--	79	3,201	3,224
Venezuela	573 r/	19,861	26,996	780	26,730	34,863
Other	6	635	906	8	977	1,271
Total 4/	2,548 r/	101,521	123,273	3,027	123,336	151,732

r/ Revised.
1/ For all types of hydraulic cement. Includes imports into Puerto Rico.
2/ Customs value. The price actually paid or payable for merchandise when sold for exportation to the United States, excluding U.S. import duties, freight, insurance, and other charges incurred in bringing the merchandise to the United States.
3/ C.i.f. (Cost, insurance, and freight). The import value represents the customs value plus insurance, freight, and other delivery charges to the first port of entry.
4/ Data may not add to totals shown because of independent rounding.

Source: U.S. Bureau of the Census.

TABLE 22
HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

Country	1993	1994	1995	1996	1997 e/
Afghanistan e/	115	115	115	116	116
Albania e/	200	200	200	200	150
Algeria	6,400 e/	6,060	6,822	6,900 r/	7,000
Angola e/	250	250 r/	250 r/	270 r/	301 2/
Argentina	5,647	6,276 r/	5,447	5,117	5,447 p/
Armenia	200	100	228	282	297 2/
Australia e/	5,500	6,500	6,500	6,500	6,500
Austria	4,941	4,828	3,843	3,874 r/	3,852 2/
Azerbaijan	600	500	200	200	315 2/
Bahrain	225	225 e/	197	193	172 2/
Bangladesh e/ 3/	275 2/	280	280	285	285
Barbados	62	78	75 r/	107 r/	173 2/
Belarus	1,900	1,488	1,235	1,467	1,876 2/
Belgium	7,612	9,000 r/ e/	8,700 r/ e/	6,996 r/	7,001 2/
Benin	506 r/	465 r/	579 r/	580 r/ e/	550
Bhutan e/	108 2/	120	140	160	160
Bolivia	654	768	892 r/	934	892 p/
Bosnia and Herzegovina e/	150	150	150	150 r/	200
Brazil	24,843	25,230 r/	28,256	34,597	38,096 2/
Brunei	--	--	--	100 e/	100
Bulgaria	2,007	2,200	2,070	2,137 r/	2,100
Burma	400	470	517	505	516 2/
Cameroon e/	620	620	620	600	600
Canada	6,672	10,584	10,440	11,587 r/	12,015 p/
Chile	3,021	2,995	3,275	3,634	3,877 2/
China	367,880	421,180	475,910	491,190 r/	492,600 2/
Colombia	7,930	9,322	9,624	8,254 r/	7,854 2/
Congo (Brazzaville) e/	114	114	100	100	20
Congo (Kinshasa) e/ 4/	149 2/	50	25	10	10
Costa Rica	860	940	865 r/	830 r/	850
Côte d'Ivoire e/	500	500	500	500	500
Croatia	1,683	2,055	1,708	1,842	2,134 2/
Cuba	1,049	1,081	1,470 r/	1,453	1,713 2/
Cyprus	1,089	1,053	1,021	1,000 r/ e/	1,000
Czech Republic	5,393	5,303	4,825	5,011	5,000
Denmark (sales)	2,270	2,430	2,584	2,629	2,683 2/
Dominican Republic	1,271	1,303 r/	1,092 r/	1,478 r/	1,500
Ecuador	2,098	2,164	2,616 r/	2,677	2,688 p/
Egypt	16,000	17,000 r/ e/	17,665	18,000 e/	18,000
El Salvador	861	850	890 r/	948	960
Eritrea 5/	-- r/	45 r/ e/	50	47 r/	47
Estonia	500 e/	402	417	388 r/	400
Ethiopia	350 r/ e/	464 r/	611	650 r/ e/	650
Fiji	80	94	91	84 r/	84
Finland	835	864	907	975 r/	960
France	20,464	21,296	19,692	18,340 r/	19,000
Gabon	132	126	154 r/ e/	180 r/	200
Georgia	300	100	100 e/	85 r/	91 2/
Germany	36,649	40,380	37,480 r/	36,104	37,000
Ghana	1,203	1,346	1,300 r/ e/	1,400 e/	1,400
Greece	12,618	12,636	12,500 r/ e/	13,000 r/ e/	13,000
Guadeloupe e/	230	230	230	230	230
Guatemala	1,119	1,200	1,152 r/	1,090	1,280 2/
Haiti e/	100	75	-- r/	-- r/	--
Honduras	723	1,100 e/	721 r/	952 r/	980
Hong Kong	1,712	1,927	1,913	2,027	1,925 2/
Hungary	2,533	2,813	2,875	2,776	2,800
Iceland	86	81	82	88 r/	88
India e/	53,812 2/	57,000	62,000	75,000 r/	80,000
Indonesia	18,934	21,907	23,129	25,000 e/	26,000

See footnotes at end of table.

TABLE 22--Continued
HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

Country	1993	1994	1995	1996	1997 e/
Iran e/	16,000	16,000	16,300	18,000 r/	18,000
Iraq e/	2,000	2,000	2,108 2/	2,100	2,100
Ireland	1,450 r/	1,623 r/	1,730 r/	1,800 r/ e/	1,800
Israel	4,536	4,800	6,204 r/	6,700 r/ e/	6,700
Italy	33,771 r/	32,713 r/	33,715	33,327 r/	33,721 2/
Jamaica	451	445	522 r/	555	600
Japan	88,046	91,624	90,474	94,492	91,938 2/
Jordan	3,514	4,000 e/	3,508	3,415 r/	3,251 2/
Kazakstan	4,000	2,000	2,616	1,120 r/	661
Kenya	1,417	1,182 r/	1,122 r/	1,102 r/	1,150
Korea, North e/	17,000	17,000	17,000	17,000	17,000
Korea, Republic of	47,313	50,730	55,130	57,260 r/	59,796 2/
Kuwait e/	500	1,000	1,950 2/	2,000	2,000
Kyrgyzstan	700	40	300	500	658 2/
Laos e/	7	10	10	9 r/	9
Latvia	300 e/	244	203	325 r/	246 2/
Lebanon e/	3,000	3,450	3,538 2/	3,700 r/	4,000
Liberia e/	8	10 r/	10 r/	10 r/	10
Libya	2,300 e/	2,700 e/	3,210	3,550	3,500
Lithuania	1,000 e/	736	649	600 e/	600
Luxembourg	720 r/	711 r/	714 r/	667 r/	700
Macedonia	499	486	524	491 r/	500
Madagascar e/	60	60	60	60	60
Malawi	127	122	139	140 e/	140
Malaysia	8,797	9,928	10,713	12,349 r/	12,700 2/
Mali e/	20	15 r/	13 r/	15 r/	15
Maritinique e/	220	220 r/	220 r/	220 r/	220
Mauritania e/	111	374	120	120 e/	125
Mexico	27,120	29,700	23,366	25,366 r/	27,548 2/
Moldova	100	39	49	40 r/	122 2/
Mongolia	82	86	109	106	112 2/
Morocco	6,350 e/	6,350 r/	6,401	8,000 r/	8,000
Mozambique e/	20	60 r/	60 r/	100 r/	200
Nepal	274	316	327	309 r/	300
Netherlands	3,078 r/	3,180 r/	3,200 r/ e/	3,300 e/	3,000
New Caledonia e/	90	90	100	100	100
New Zealand e/	800	900 r/	950 r/	974 r/ 2/	976 2/
Nicaragua	255	309	324 r/	350	360
Niger e/	29	30	30	30	30
Nigeria e/	3,200 r/	2,600 2/	3,000	3,000	3,000
Norway	1,344	1,444	1,613	1,664 r/	1,700
Oman	1,000 e/	1,200 e/	1,177	1,260 r/	1,300
Pakistan	8,321	8,100	8,586	8,900 e/	9,000
Panama	571	615	615 r/	647 r/	610
Paraguay	490	570	635	620	620 p/
Peru e/	2,500	3,000	3,000	3,848 2/	3,000
Philippines e/	7,962 2/	10,400	10,600	12,000	15,000
Poland	12,228	13,834	13,884	13,879	14,910 2/
Portugal	7,617 r/	7,977 r/	8,123 r/	8,300 e/	8,500
Qatar	544 r/	469 r/	475 r/	690	700
Romania	6,240	5,998	6,842	6,956 r/	7,298 2/
Russia	49,900	37,200	36,500	27,800	26,600 2/
Rwanda e/	60	10	5 2/	5 r/	5
Saudi Arabia	15,300 e/	15,000 e/	15,773	16,437	15,400 2/
Senegal e/	590 2/	590	650 r/	700 r/	700
Serbia and Montenegro	1,088	1,612	1,696	2,205	2,011 2/
Singapore e/	2,980	3,100	3,200	3,300	3,300
Slovakia e/	2,500	2,500	2,500	2,500	2,500
Slovenia	707	898	991	900 r/	900
Somalia e/	25	25	25	30	30
South Africa	7,356	7,905	9,071	9,000 r/ e/	9,000

See footnotes at end of table.

TABLE 22--Continued
HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

Country	1993	1994	1995	1996	1997 e/
Spain (including Canary Islands)	22,878	25,150	26,423	25,157	27,632 2/
Sri Lanka	676	925	900 e/	905 e/	910
Sudan e/	250	250	391 2/	380	380
Suriname e/	50	50	50	50	50
Sweden	2,162 r/	2,153 r/	2,339 r/	2,447	2,320 2/
Switzerland e/	4,000	4,300	4,000 r/	3,800 r/	3,800
Syria	4,500	4,500 e/	4,463	4,500 r/ e/	4,500
Taiwan	23,971	22,722	22,478	21,537	21,522 2/
Tajikistan	300	200	100	50	35 2/
Tanzania e/	540	490	800	800	800
Thailand e/	26,870 2/	29,900	34,900	35,000	36,000
Togo e/	350	350	350	350	400
Trinidad and Tobago	528	583	559	617	653 2/
Tunisia	4,269	4,606	4,938	4,567	4,431 2/
Turkmenistan	1,100	700	437	451	450
Turkey	31,241	29,493	33,153 r/	35,214 r/	36,035 2/
Uganda e/	50	42 r/	85 r/	150 r/	150
Ukraine	15,000	11,400	7,600	5,000	5,100 2/
United Arab Emirates e/	4,000	5,000	5,918 2/	6,000	6,000
United Kingdom	11,039	12,307 r/	11,805	12,214 r/	12,900
United States (including Puerto Rico) 6/	75,117	79,353	78,320	80,818	84,255 2/
Uruguay	500 e/	700 e/	600	685	700 p/
Uzbekistan	5,300	4,800	3,400	5,000	5,000
Venezuela	6,842	6,927 r/	7,672 r/	7,556 r/	7,600
Vietnam e/	4,200	4,700	5,200	5,700	6,000
Yemen	800 e/	800 e/	1,088	1,040	1,100
Zambia e/	350	280 2/	250	350	300
Zimbabwe	1,000 e/	1,070	1,100 r/ e/	1,150	1,150
Total 7/	1,290,905 r/	1,373,013 r/	1,443,328 r/	1,488,262 r/	1,515,442

e/ Estimated. p/ Preliminary. r/ Revised.

1/ Table includes data available through September 22, 1998. Data may include clinker exports for some countries.

2/ Reported figure.

3/ Data for year ending June 30 of that stated.

4/ Formerly Zaire.

5/ Eritrea became an independent country in May 1993.

6/ Portland and masonry cement only.

7/ Data may not add to totals shown because of independent rounding.