CEMENT

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Concrete and mortar are basic construction materials that comprise mixes of hydraulic cement, aggregates (fine and coarse aggregates in concrete, fine sizes only in mortars), and water that, through complex hydration reactions in the cement, harden into rocklike masses with specific properties. As the binding agent in concrete and mortar, cement is basic to most construction activity, and the production and consumption of cement are thus fundamental indicators for a country's construction industry. Summary data on U.S. cement production, consumption, and trade are given for 1994 through 1998 in table 1, with production details for 1997-98 being shown in tables 3 through 6. In 1998, total U.S. production of portland and masonry cements reached a new record of 83.9 million metric tons (Mt), of which 95% was portland cement, and clinker production reached a new record level of 74.5 Mt. Clinker and cement output continued to be at or near full practical capacity levels. The United States ranked second in the world in cement production; world output was about 1.5 billion metric tons (Gt) (table 23).

Consumption of cement in 1998 was again at record levels. Apparent consumption of cement increased by 7.8% to 103.5 Mt and consumption measured as sales to final domestic customers rose by 7.2% to 103.4 Mt (table 9)—the first time either measure has exceeded 100 Mt. Imports of cement rose dramatically to meet this excess demand. Exports remained a very small component of total U.S. cement trade and again declined slightly during the year. As in 1997, the availability of inexpensive imported material appeared to have constrained price increases. The total ex-plant value reported for annual cement shipments from mills and terminals to final customers increased by 12% to about $7.4 billion. The same unit values applied to reported larger tonnage sales to final customers yielded a total value for 1998 of about $7.9 billion, an increase of 11%. By using typical cement-in-concrete mix ratios, the delivered value of concrete, excluding mortar, in the United States was estimated to be at least $30 billion in 1998.

Hydraulic cements are those that will set and harden in 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 and similar cements, including derived masonry cement. Except for certain trade and international production data, this report is concerned only with portland, as broadly defined, 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.

In the strictest sense, the term "portland cement" refers to the finished product, which is a finely interground mixture of portland cement clinker and 3% to 5% gypsum. A few States allow the addition of 1% to 3% of other cementitious material, such as granulated blast furnace slag, either as an extender or as a grinding aid, within the (straight) portland cement designation. Portland cement can be made by either integrated cement plants, which both manufacture clinker and grind it to make cement, or by stand-alone grinding facilities that use 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, as needed, lesser quantities of siliceous, aluminous, and ferrous materials. 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, denoting such properties as high sulfate resistance and high early strength, are recognized. Other designations may be used in other countries for similar portland cements. Portland cement is almost always gray, but a more valuable variety, white cement, can be obtained if care is taken to burn only iron-free raw materials.

Within statistical reporting of portland cement, common U.S. industry practice includes all nonmasonary cement varieties that are broadly based on portland cement clinker; this includes so-called blended cements. Blended cements are interground mixtures of finished portland cement (or ground clinker plus gypsum) and cementitious or pozzolanic additives. The proportion of these additives is quite variable but is commonly in the range of 15% to 50% by weight. Broadly defined, pozzolans are siliceous materials, such as certain rocks [mainly tuffs, diatomaceous earths, and burned clays or shales] and industrial byproducts [mainly ground granulated blast furnace slag, fly ash, cement kiln dust (CKD), and silica fume], that exhibit hydraulic cementitious properties when finely ground and interacted with free lime and water. In a blended cement, the free lime is that released during the hydration of portland cement. Blended cements have similar final strengths as straight portland cements, commonly have improved resistance to certain types of chemical attack, and offer low heat of hydration and reduced environmental impact of manufacture.

With the exception of table 16, blended cements are included within the portland cement designation in this report. Blended cement data (beginning with January 1998) are also available in separate Minerals Industry Surveys publications of the U.S. Geological Survey (USGS) showing monthly sales volumes by State. These data show that sales of blended cement make up only about 1.2% of total cement sales. However, these data (and those for cement raw materials in table 6) significantly underrepresent the use of pozzolans in making concrete, because many concrete companies buy pozzolans, especially fly ash and ground granulated blast furnace slag, directly and mix them with purchased straight portland cement instead of buying blended cement. Various sales data for fly ash and slag and limited surveys of concrete manufacturers suggest that, on average, pozzolans now compose, at least in some regions, perhaps as much as 10% of the cementitious material in ready-mixed concrete, which is the major form of concrete manufactured.

The determination of pozzolan consumption levels in the United States is complicated by the fact that some "pure" pozzolan cements are consumed. Blended cements rely on the lime released by the hydration of portland cement in the mix to activate the pozzolans, whereas pure pozzolan cements contain no portland cement and the required lime or other activator must therefore be added. Consumption data for pure pozzolan cements are lacking, but levels are likely very small. A further complication stems from the fact that data from pozzolans suppliers tend to lump sales to the cement and concrete manufacturers and commonly do not differentiate sales of pozzolans from similar but nonreactive material used as aggregates or as kiln feed.

As with portland cement, the term "masonry cement" is used broadly in this report and includes portland lime and plastic cements. Because this combination is not the universal practice of the industry, some portland lime and plastic cement data may have been reported within the portland cement designation, particularly in the monthly sales data summed within tables 9 and 10. Overall, however, the misassigned tonnages likely are small. Masonry-type cements are used in mortars, which are pastes for binding together building blocks, such as bricks and stones. Masonry cements can be made either from portland cement or directly from clinker and incorporate high percentages (e.g., 30% to 50%) of additives, 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, underestimate the true production and consumption of this material.

The bulk of this report, particularly tables 1 through 8 and 11 through 16, incorporates and discusses data compiled from USGS[1] annual surveys of individual cement and clinker manufacturing plants and certain terminals and importers. The 1998 survey form differed from that of 1997, primarily in that the 1998 form queried additional details concerning sales of blended cements and of consumption of raw materials. In 1998, responses were received from 134 of the 138 facilities canvassed, including all but 3 small producers, 1 of which had shut early in the year; the reporting facilities accounted for more than 99% of total U.S. cement production and shipments. In 1997, responses were received from 135 of the 136 facilities canvassed, recording 100% of production and more than 99% of shipments. Tables 9 and 10, 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. The annual and monthly canvasses solicit data in short tons and other nonmetric units. The data are then converted for reporting purposes to metric units (sometimes in thousands), and rounding errors are possible, particularly within tabulated U.S. totals.

For annual survey nonrespondents and in cases where questionnaires were returned incompletely or improperly filled out, follow up 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, however, continue to be the data for values shown in tables 1 and 12 through 14, where a significant but declining number of facilities routinely omit or incorrectly report the information, and the data for portland cement shipments by customer (user) type, shown in table 15, where the cement producers readily admit to having incomplete knowledge and where there is some overlap among the user categories.

As in previous years, the tonnage discrepancy between the annual shipments totals for portland cement shown in tables 1 and 11 through 16 and the larger, monthly-data-based totals shown in tables 9 and 10 is significant. The discrepancy appears due mainly to the fact that the monthly surveys commonly are returned by companies on a consolidated basis inclusive of several plants and/or terminals, whereas the annual surveys are returned by individual plants and some terminals, but some terminals may be missed. Particularly if imports are involved, missing terminals can individually account for substantial tonnage differences. Errors with the monthly reporting, in contrast, generally are smaller on an individual respondent basis, and most commonly are from the mistaken inclusion by companies of some sales to other cement companies instead of just sales to final customers (this leads to double-counting). Corrections of such errors generally are submitted to the USGS within a month or two. Unlike the case with portland cement, the difference in the totals for the two reporting systems for masonry cement is small. Because they are more complete, the data in tables 9 and 10 are the preferred measure of true U.S. consumption (see Consumption section); these data (actually the component monthly data) are used by cement companies to estimate their market shares and to perform many other economic analyses. Integration of the data from tables 9 and 10 with those from the other tables has not been done to avoid creating additional internal inconsistencies.

Tables 17 through 22 show nonproprietary trade data from the Bureau of the Census in lieu of the proprietary data collected through the USGS monthly questionnaires. The world hydraulic cement production data shown in table 23 were derived by USGS country specialists from a variety of sources.

In some tables, State data are combined within State groupings or districts, generally corresponding to Census Districts or subsets thereof, where required to protect

[1]Data in table 1 for 1994 were collected by the former U.S. Bureau of Mines.

proprietary information. To provide additional market information, certain major cement-producing States have been subdivided along county lines; the county breakouts are given in table 2.

Several important changes in cement company and/or plant ownership took place in 1998. On January 1, the purchase of Riverside Cement Co., a California company, by Texas Industries, Inc. (TXI), based in Texas, came into effect. The deal for this had been signed the previous September (International Cement Review, 1999). The seller was Ssangyong Cement Industrial Co., Ltd., a Korean company. At the end of June, Southdown, Inc., the country's third largest cement producer, purchased Medusa Corp., the eighth largest producer (Southdown, Inc., 1999a, p. 40); the merger moved Southdown ahead of Lafarge Corp. as the second largest cement company in the country. In mid-October, Lafarge completed its purchase of an integrated plant in Seattle, WA from Holnam, Inc. (Lafarge Corp., 1998). In July, the U.S. and Canadian operations of Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement, Inc., of Germany, and Cimenteries CBR S.A., a Belgian company 55.9% owned by Heidelberger, were formally merged under the Lehigh name (Cimenteries CBR S.A., 1999, p. 5). The North American CBR operations thus affected were those of Calaveras Cement Co., in California; Tilbury Cement Ltd., in Canada and Washington; and Inland Cement Ltd., in Canada.

Legislation and Government Programs

Economic Issues.—Government economic policies and programs affecting the cement industry chiefly are those affecting cement trade, interest rates, and public sector construction spending. In terms of trade, the major issue in 1998 remained that of antidumping tariffs against Japan and Mexico, and a related voluntary restraint (import price) agreement with Venezuela, that were imposed in 1990 and 1992 following complaints in the late 1980's by a large coalition of U.S. producers. The complaints stemmed from the large volumes of inexpensive cement and clinker imports that were undercutting U.S. producers' prices. Anticipation and eventual imposition of tariffs on Mexican imports led to a decline from a peak of 4.5 Mt in 1988 to 0.6 Mt in 1994, but they have been recovering somewhat since, and reached almost 1.3 Mt in 1998. The main Mexican company involved has repeatedly appealed the tariffs, but the appeals to date have all been turned down and the tariffs reaffirmed. In March 1998, the U.S. Department of Commerce released its determination for the (sixth) review period covering August 1995 through July 1996; the tariff for Mexican cement imports was set at 36.3% for the period (Southern Tier Cement Committee, 1998a). In early December, a North American Free Trade Agreement binational dispute resolution panel rejected an appeal of the 109.43% fourth review period tariff, covering imports for August 1993 through July 1994, from the main Mexican producer affected (Southern Tier Cement Committee, 1998b). The antidumping tariffs caused cement imports from Japan to drop to negligible levels by 1993, and they have remained so since. The agreement with Venezuela allowed substantial import levels to continue, but at higher prices than before. In line with a World Trade Organization (WTO) agreement, which became effective in 1995, antidumping tariffs can be imposed only for a period of 5 years, afterwhich a "sunset" review must be done to determine whether or not a need (determination that dumping is occurring and is causing injury) remains for the tariffs. In the case of the antidumping tariffs on cement (which were imposed prior to the WTO agreement), the requisite sunset review was to start in August 1999 (Dorn, 1999)

Public Law 105-178, the Transportation Equity Act for the 21st Century (TEA-21), signed into law June 9, 1998, authorizes $216.3 billion in funding for the 6-year period 1998-2003 for the purpose of upgrading the country's transportation infrastructure. The level of funding exceeds previous spending levels by about 44%, on a State average basis, and the bill contains substantial funding guarantees. The source of most of the funding is the Highway Trust Fund, composed mainly of Federal motor fuel tax revenues. Of greatest interest to the cement industry are the highway components in TEA-21. Funding provided for various facets of highways, including new roads and bridges and existing infrastructure upgrades and repair, totals about $173 billion, of which about 95% is guaranteed. Various estimates have been made as to how much (added) cement consumption will result from full-level TEA-21 spending; most of the studies have agreed on the range of 6 to 8 million metric tons per year (Mt/yr) (e.g. Kasprzak, 1999).

Environmental Issues.—Cement production has both mining and manufacturing components. In the United States, about 135 Mt of nonfuel raw materials are directly or indirectly mined (see table 6) each year for cement manufacture, generally from open pit operations close to the cement plant. Environmental issues affecting this activity are common to most surface mines and include potential problems with dust, increased sediment loads to local streams, noise, and ground vibrations from blasting. Of greater concern overall are the environmental impacts of the cement manufacturing process itself, most of which stem from the manufacture of clinker. Clinker kilns burn about 12 Mt/yr of fossil and/or other organic fuels (table 7) to thermo-chemically break down (calcine) calcareous and other rocks to instigate clinker-mineral-forming chemical reactions.

In the debate over climatic change, the impact of "greenhouse gases" on atmospheric warming is a major issue. The most common greenhouse gas is carbon dioxide (CO_2), and both fuel combustion and calcination of carbonate (limestone) feed in the clinker kilns generate large quantities of this gas. As explained more thoroughly in the 1996 edition of this report, 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% on the basis of 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. If a lime or calcia (CaO) content in clinker of 65% is assumed and if it is assumed that all of this CaO is derived from calcium carbonate then calcination can be assumed to yield 0.51 metric ton (t) of CO_2 per ton of clinker. If some CaO in clinker is derived from other sources, such as slag feeds, then the amount of CO_2 released by calcination will be less. Calcination also involves other variables, but they are relatively minor. Fuel consumption is technology dependent and is subject to more variables, but the combustion component may be estimated at about 0.48 to 0.50 t of CO_2 per ton of clinker, on the basis of the mix of fuels shown in table 7. Thus, overall, about 1 t of CO_2 is released per ton of clinker produced, which translates to about 0.95 to 0.97 t of CO_2 per ton of portland cement produced. Because of their substantial component of materials other than portland cement or clinker, masonry cements generally equate to less CO_2 per ton of product than portland cement. Masonry recipes vary widely, but if the additives are mostly ground limestone, then the total CO_2 released would be about one-half to one-third that of portland cement. If lime is the additive, then the total is closer to, but less than, that of portland cement because lime manufacture uses less fuel than clinker manufacture. Calculation of CO_2 emissions from calcination is better done, as above, from data on clinker production rather than applying emissions factors to mix of raw materials burned (e.g. table 6), because data will seldom, if ever, be available on a national basis for the chemical composition of these feeds. Calculation of emissions based on data for cement production can introduce large errors unless the breakout of cement, by type, is well known and the composition of each type of cement is also known. This level of detail is generally lacking in production data for cement, but it is important, particularly if the cements incorporate significant amounts of pozzolans; that is, are blended cements. Most blended cement specifications allow significant compositional variations. Many pozzolans, especially fly ash and blast furnace slag, are themselves products of major CO_2-generating industries, such as coal-fired powerplants and blast furnaces, but the emissions from this manufacture would be charged to those industries.

By using the clinker data in table 5, release of CO_2 by cement manufacture in the United States is estimated at about 75 Mt in 1998. In addition, U.S. cement plants consumed electricity (table 8) equivalent to about 7 to 8 Mt of CO_2, but this generally would be charged to the electrical power industry.

The concern of the cement industry with CO_2 emissions continues to be 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 1997 in Kyoto, Japan, measures were agreed to that would have so-called developed countries reduce their emissions of greenhouse gases to levels below those of 1990; for the United States, the Kyoto Protocol reduction requirement was 7% below 1990 levels, by 2012. Current U.S. emissions of greenhouse gases are substantially higher than the 1990 levels; estimates of the margin vary but typically are in the range of 20% to 25%. Consequently, the Kyoto targeted reduction for the United States is substantial. At least initially, developing countries would be encouraged, but not required, to reduce their emissions of greenhouse gases. Detailed methodologies were being developed by the Intergovernmental Panel on Climate Change (IPCC) to estimate the amount of CO_2 and other greenhouse gases emitted by various industries, including cement, and other national-level sources, and based to the degree possible on readily obtainable product output data. To this end, the IPCC held an international conference in January 1999 in Washington, DC.

It remains unclear how a large reduction in U.S. CO_2 emissions could be achieved without substantial increases in energy and general production costs throughout the economy, or without having domestic manufacturers facing increased competition from imports originating in countries not encumbered by the Kyoto-mandated emissions reductions. Although the United States signed the Kyoto Protocol on November 12, 1998, Congress has yet to ratify the agreement, which is nonbinding until this happens. Even without ratification, the cement industry expected that the Government would encourage a reduction in CO_2 and other greenhouse gas emissions (Cement Americas, 2000).

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, and/or the upgrading of plant equipment to more efficient technologies. Upgrading is already underway at many plants, but is an expensive process. Mandated emissions reductions could force plants to burn less carbon-intensive fuels; for example, natural gas rather than coal. This is technically easy to do, as many cement plants in the United States are already able to switch among a variety of fuels. A shift towards natural gas consumption by the cement industry could, however, lead to local shortages and price increases for that fuel, particularly if a switch to gas is also made by other major fuel-burning industries, such as powerplants. A significant contribution to the 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 domestic 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 general shift to their use would require changes in some 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 and increased prices for these materials. As noted above, many concrete manufacturers are already using substantial quantities of cementitious additive in their concrete mixes. Although this practice could be slightly constraining U.S. cement imports, it has yet to impact domestic cement (clinker) manufacture. Another approach to reducing the clinker impact of cement manufacture is to reduce the emissions from calcination by using alternative sources of CaO as feed. A process patented by TXI and known as CemStar makes use of substitution for some of the kiln feed by steel slag. The slag, apart from supplying a measure of needed CaO, supplies silica and iron oxide, is said to melt very easily, has a mineralogy similar to that of clinker, and reacts exothermically;

its use is claimed to increase the existing kiln's clinker output by up to about 10%, with unit emissions proportionately lower. The process has been licensed to a number of plants (Texas Industries, Inc., 1998).

Another major waste product of clinker manufacturing is 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 a national average, about 70% 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, or in the product line as additives in masonry cements or even as a pozzolan. The remaining CKD, amounting to about 3 Mt/yr, is removed to landfills; this is required for CKD that contains contaminants (e.g., excessive alkalis, chromium, vanadium, and toxic organic compounds) at concentrations that preclude recycling. The U.S. Environmental Protection Agency (EPA) was studying whether to classify CKD as a hazardous waste and was drafting regulations pertaining to its handling and storage. A draft set of proposed regulations was released by EPA during the year but, following extensive comments by the industry, the agency agreed to revise the document; the revision had not been released as of yearend. Commentaries, from the cement industry standpoint, on the proposed regulations are provided by Kelly (2000) and Weiss (2000).

Government proposals to reduce cement industry emissions of nitrogen oxides (NOx) and sulfur oxides (SOx), dioxins and furans, and other contaminants are of concern to the industry, particularly because changing emission limits may necessitate changes in testing procedures, equipment, and operating practices. These limits also affect the ability of plants to use 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. EPA had issued preliminary MACT standards in 1996, but had not issued final standards as of yearend 1998.

Production

In 1998, cement was produced at 118 plants in 37 States and in Puerto Rico, by 39 companies (other company totals are possible depending on ownership breakdowns), 1 of which was State-owned. Production and related data are shown in tables 3 through 8. As of yearend 1998, about 60% of U.S. cement production and 61% of capacity was foreign owned.

Many cement companies were in the process or planning stages of upgrading their production facilities to increase production efficiencies and/or overall production capacity. Among the projects announced or completed during the year, Ash Grove Cement Co. completed the upgrade of the Durkee, OR, plant to about 0.85 Mt/yr capacity (Portland Cement Association, 1998a). California Portland Cement Co. was planning to upgrade its Rillito, AZ, plant to a capacity of about 2.1 Mt/yr of cement (Portland Cement Association, 1998d). Essroc Materials Corp. brought back on line a 0.1-Mt/yr kiln at Nazareth, PA (Portland Cement Association, 1998b). North Texas Cement Ltd. announced plans to construct a 1-Mt/yr cement plant near Dallas, TX (World Cement, 1998); construction was expected to be completed in early 2001. St. Lawrence Cement, Inc. announced plans to build a 2-Mt/yr cement plant at Greenport, NY (St. Lawrence Cement, Inc., 1998). Southdown, Inc. was continuing extensive upgrades at its Victorville, CA, plant, and announced a 0.6-Mt/yr expansion of the Kosmosdale plant at Louisville, KY; this facility is a joint venture between Southdown (75%) and Lone Star Industries, Inc. (25%) (Southdown, Inc., 1999a, p. 24). TXI was building a new 1.8-Mt/yr kiln at its Midlothian, TX, plant (International Cement Review, 1999). Monarch Cement Co. was planning to upgrade its Humboldt, KS, plant to a capacity of about 0.9 Mt/yr (Portland Cement Association, 1999a). National Cement Co. was installing a new preheater tower at its Lebec, CA, plant to increase capacity to almost 0.9 Mt/yr (Portland Cement Association, 1998c).

Royal Cement Co., Inc., a small integrated plant in southern Nevada, closed at the end of March 1998; this was the only portland cement plant closure during the year. Lehigh, however, closed its Buffington, IN, calcium aluminate cement plant, intending to replace its output with that from a facility in Pula, Croatia (Cimenteries CBR, S.A., 1999, p. 40).

Portland Cement.—In the United States and Puerto Rico, portland cement was manufactured at 115 plants out of 116 claiming clinker-grinding capacity (the remaining plant only reported masonry cement production). Five of the portland-producing facilities were dedicated clinker-grinding plants; some of these also ground slag. The regional distribution of these plants, cement production and capacities, and yearend cement stockpiles, are given in table 3.

In 1998, portland cement production rose by 1.3% to a new record of almost 80 million tons. Nevertheless, the increase was modest compared with the large increase in sales noted in the Consumption section below and in table 9. The production shortfall reflected the as-yet unfinished status of a number of production-capacity upgrade projects and the ready availability of imported cement. In the case of some grinding plants, imported cement allowed the switch of some grinding capacity over to grinding imported granulated blast furnace slag. As shown in table 3, portland cement production increases were noted in most districts. As in 1997, the top five producing States in 1998 were, in descending order, California, Texas, Pennsylvania, Michigan, and Missouri.

Portland cement (grinding) capacity utilization continued at very high levels nationwide— about 85% overall. This statistic, however, is misleading in that it compares the reported grinding capacity with only the portland cement output. A better average would result by including the masonry cement tonnage (table 4), which would increase the overall grinding capacity utilization for the country to 89%. Given the fact that the reported (plant) capacities are supposed to exclude all but routine downtime, the utilization levels shown are likely to be at or very close to practical limits. Some of the 1997-98 changes could reflect capacity improvement projects underway at various plants. When completed, such upgrades would be expected to yield production increases, but where ongoing, the projects might cause short-term decreases in outputs if major equipment were to be shut down for alteration or replacement. Some of the changes shown could simply reflect a difference in reporting personnel or in different interpretations of what defines capacity. Thus, small district capacity changes shown for total U.S. grinding capacity and capacity utilization in 1998 are likely not statistically significant. The significant increase in capacity utilization seen for Ohio largely reflects the reduced State capacity stemming from the early 1997 closure of a grinding plant. As in previous years, the 1998 regional grinding capacities shown substantially exceed those for clinker given in table 5. The main reasons for this are the inclusion of grinding plants that produce cement but not clinker in table 3; some plants have extra capacity for grinding imported domestic or foreign clinker and/or inert or pozzolan extenders; and it is cheaper to construct grinding capacity than clinker capacity.

Reported yearend 1998 portland cement stockpiles were about 0.38 Mt lower than those in 1997, but the evaluation of stockpile changes, especially small ones, is difficult for several reasons. An increase in yearend stocks could represent a buildup of material ahead of shutting down kilns and/or finish mills (for routine maintenance or other work) to allow plants to continue their normal sales deliveries of cement. The timing of such shutdowns can vary regionally. Cement stockpile buildups would normally follow those for clinker, data for which were unavailable prior to 1998. Thus, the most meaningful stockpile data would be for those at the end of a kiln and/or mill shut-down period for major maintenance or other work. Collection of such data, as opposed to those for a uniform date, is impractical, however. Buildups could represent the coming on-stream or the reaching of full production levels of new or upgraded production capacity. Changes in yearend stockpiles could reflect changes in sales volumes towards yearend or buildups in anticipation of sales to major projects. They can reflect mass changes associated with conversion to other types of cement, such as a "straight" portland cement being converted to a larger mass of blended or a masonry cement. In the case of imports, the yearend stockpiles could be influenced by the early or delayed arrival of ships. 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 of portland 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 shown in table 16. Assuming this to be true, 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 operating a single plant of less than 0.5% of total U.S. capacity to large, multiplant corporations having in excess of 15% of total capacity. The ranking of these companies in terms of production and capacity is complicated by the facts that some companies are subsidiaries of common parents and that some plants are jointly owned by two or more companies. Consolidating companies having common parents and apportioning the joint ventures, the top 10 companies in 1998 were, in descending order of production, Holnam; Southdown; Lafarge; Lehigh; Blue Circle, Inc.; Ash Grove; Essroc; Lone Star; California Portland; and TXI. These, combined, accounted for 70% of U.S. portland cement production and 80% of capacity in 1998.

Masonry Cement.—Masonry cement production, as shown in table 4, increased by 9.8% to almost 4 Mt. Unlike the case with portland cement, the level of masonry cement production was very close to that of consumption (table 9). The change in stockpiles shown was minor. The large percentage increases in production and consumption reflect a strong housing market during the year, the small total tonnages involved, and the corrected reporting of sales of some types of masonry cement that had hitherto been erroneously reported within those of portland cement by some companies. In 1998, masonry cement was again produced by 83 plants, all but 2 of which also produced portland cement. As in 1997, about 94% of total masonry cement was produced from clinker, as opposed to being produced from portland cement. As noted in the introduction, these data underrepresent true output and consumption levels of masonry cement because some varieties, especially portland lime cement, can be easily mixed on the job site using purchased portland cement as the base.

Clinker.—The production of clinker increased by 2.5% to 74.5 Mt, another new record. Output increased in all but a few districts; none of these showed large declines. 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 lists district-level information on clinker production and capacity. Capacity utilization for the country was about 90%, and all but two districts had utilization levels in excess of 82%. The Oregon-Washington district showed an abnormally low utilization level that was at least partly due to disruptions (including in data reporting) occasioned by a change in ownership of one plant during the year.

As with clinker (cement) grinding capacities discussed above, clinker output levels in 1998 continued to represent full or nearly full practical output levels. The clinker capacity and utilization data for 1998 and 1997, however, are not strictly comparable with data for earlier years. This is because of problems apparent in the pre-1997 reporting of the breakout of kiln downtimes by some plants. The time breakdown is critical to the derivation of annual capacities (calculated by multiplying plant-reported daily capacities by the normal operating year, which is defined as 365 days minus the days of routine maintenance downtime) for each kiln. For the 1997 and 1998 surveys, plants that reported in excess of 30 days of routine downtime were contacted to verify the correctness of the data. In most cases, these plants had originally overstated the routine downtime and understated the "other" downtime; corrected distributions were then obtained. If the days for routine downtime are overstated, then the calculated annual capacity for that plant will be too low, and the capacity utilization subsequently calculated will be too high. Some districts, in years prior to 1997, showed utilization levels in excess of 100%, which is unlikely for an entire district over the course of a year, especially for an industry that runs its facilities 24 hours per day. Plants that reported 30 or fewer days of routine downtime were assumed to have reported correctly, but this may not, in fact, be the case. Apart from these considerations, the daily and annual capacity data in table 5 are particularly vulnerable to propagation of rounding errors.

In 1998, the average plant operational annual capacity was 0.77 Mt and average annual capacity per kiln was 0.42 Mt. Plants operating only dry process kilns accounted for almost 73% of total clinker production in 1998 and wet process plants slightly more than 25% of production (table 7); the slight difference seen from the 1997 distribution likely reflects the late 1997 conversion of a wet process plant to dry technology (Holnam's Devil's Slide plant in Utah).

Although data are not collected for clinker consumed to make masonry cement, the amount of masonry reported as produced directly from clinker implies a clinker consumption for this cement of about 2.5 Mt. This would leave approximately 73.3 Mt of U.S. clinker production, including that of Puerto Rico, plus 4.1 Mt of imported clinker (table 22), available for portland cement manufacture. This would be sufficient to make between 79.9 and 81.6 Mt of straight portland cement, assuming a clinker component of 95% to 97%, which compares well with the actual output of 81.5 Mt (or 81.2 Mt after adjusting for the approximate pozzolan content of blended cement "production" estimated from the sales data shown in table 16), and which would imply no significant changes in clinker stockpiles over the year. Data for clinker stockpiles were unavailable prior to 1998 and are lacking for 1998 for five plants; there was no basis on which to estimate these volumes. The 1998 data show end-of-year stockpiles for the country (including Puerto Rico) of about 2.9 Mt, an increase of 0.5 Mt from those at the beginning of 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 46% of total U.S. clinker production and capacity, and the top 10 companies had about 69% to 70% of both. In terms of ranked clinker production, the order of the top 10 companies is ownership dependent. Consolidating companies having the same parent corporations, and apportioning joint ventures, the rank of companies was, in declining order of clinker production, Holnam, Southdown, Lafarge, Lehigh, Ash Grove, Essroc, Blue Circle, Lone Star, TXI, and California Portland.

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 6. Limestone and other calcareous rocks made up about 81% of the total raw materials mix. As in previous years, approximately 1.6 tons of raw materials, including 1.3 tons of calcareous rocks, was consumed per ton of cement produced. The mass ratios among various major raw materials and the ratios of these materials to clinker and cement produced are essentially the same for 1998 and 1997.

Given increasing environmental interest in CO_2 output by cement plants and in the related, considered potentially remedial, output of blended cements and consumption of pozzolans, the 1998 survey form was redesigned so that consumption of raw materials could be apportioned between that for clinker manufacture and that subsequently used to make finished cement. Further, several additional types of materials, particularly among pozzolans and similar siliceous feeds, were specified; in prior years, data for these categories had been lumped. The breakout data are shown in table 6 but remain unavailable for 1997 and earlier years. In prior reports, the clinker-vs.-cement consumption breakout, which was based, in part, on crude comparisons of the total consumption of materials to the sales volumes of specific types (particularly blended) of cement, could only be qualitatively estimated. From the inception of the new survey, the ability of the industry to provide the additional details sought was not known. The results were better than expected, but were not completely successful. In particular, the amount of masonry cement manufactured in 1998, as shown in table 4, would support a consumption of limestone as much as double the amount shown in the "Cement" column in table 6; the missing amount presumably still resides in the "Clinker" column. The amount shown for lime likewise appears to be too low. The tonnage shown for cement kiln dust as consumed for clinker is clearly only a fraction of that actually consumed; evidently few plants quantitatively monitor the substantial amount of CKD that usually is directly recycled to the kilns. Similarly, despite being a fairly common additive in masonry cement and having some use as a pozzolan in blended cement, the amount of CKD reported as going into cement seems to be too low; the actual volume reported is subject to proprietary withholding. The categorization of certain materials that might chemically best fit into one category but that were actually consumed to supply something else continues to be a minor problem. For example, all slags were placed under the "Siliceous" feed category, but some types were actually consumed to supply iron.

In 1997 and prior years, the consumption of fly ash was shown inclusive of bottom ash, and greatly exceeded the amount that could be accommodated by the sales (as proxy for production) of fly ash blended cements shown in table 16. Accordingly, most of this material was thought to be consumed as a kiln feed; the data, as noted earlier, did not include the fly ash consumed directly by the concrete industry. The table 6 data for 1998 and the 1997 breakout shown for bottom ash clearly support the earlier years' conclusion. Almost all of this material is within the "Clinker" column and the small amount within the "Cement" column could be readily accommodated as a pozzolan in realistic proportion within the fly ash blended cement sales shown in table 16. As expected, all other forms of ash, mainly bottom ash, were entirely consumed to make clinker.

In prior years, all forms of slag were generally entered as "Blast furnace slag," although this material was thought to include steel slags, perhaps copper slags, and air cooled blast furnace slag, in addition to the granulated blast furnace slag that was actually being sought. Occasionally, a plant would specify one of these and enter it under an "Other" category. The additional slag breakout categories were made available in the 1998 survey and are shown in table 6; the inclusive 1997 slag data are now entered all as "Granulated blast furnace slag," but it remains unknown how much of this was really this material. Because the tonnage reported as "Blast furnace slag" could be accommodated by the sales of blast furnace slag blended cements (table 16) for 1996 and earlier years, essentially all of this material was thought at the time to have been consumed as a cementitious or pozzolan additive. The 1997 total seemed too high to fit within common proportions into the blended cement sales shown for the year, and a speculation was made that the data could have included misreported other slag types. The 1998 slag data strongly support a lumping of slag types in 1997, and call into question the dominantly blended cement use conclusion for 1996 and earlier years. As expected, the granulated blast furnace slag consumption in 1998 was all for finished cement. The amount shown (0.285 Mt), however, exceeded the small volume (0.165 Mt) of blast furnace slag blended cements sold to final customers (table 16); as a proxy for production, this sales volume would require a consumption more like 0.02 to 0.08 Mt of granulated blast furnace slag. Examination of the survey forms showed numerous plants consuming granulated blast furnace slag but reporting no blended cement sales. These plants were contacted to see if one or the other data category was being misreported or if granulated blast furnace slag was being used for some other purpose in the finish mills. It turned out that significant quantities of this material were being used by some plants as a grinding aid and/or as a 1% to 3% cementitious extender in Types I and II portland cements, where this use was permitted by individual States.

As expected, a significant tonnage of steel slag was reported in 1998 as having been consumed to produce clinker. This material is being increasingly used (although the data cannot, as yet, document this) as kiln feed, not only as a "casual" feed to supply iron and calcia, but also to effect an increase in the throughput capacity of the kiln by plants using TXI's patented CemStar process.

Although some CKD was reported as being used as a pozzolan, data for this use appear to be incomplete and, like those for the tiny amounts of more exotic pozzolans (such as silica fume), cannot be shown for proprietary protection reasons. In the case of silica fume, in particular, it seems likely that most of the material is consumed directly at the concrete plants and is not incorporated in a purchased blended cement.

Consumption of fuels by kiln process is shown in table 7. Overall, the consumption of coal, or coal plus coke, relative to clinker production was substantially unchanged in 1998. A significant decline in the burning of tires appears to have been offset by increased burning of coke, other solid wastes, and natural gas. The biggest changes in 1998 were seen in the large decline in fuel oil burned by plants operating wet kilns, which was offset by a very large increase in the consumption of liquid waste fuels.

Table 8 lists electricity consumption by the cement industry, differentiated by process type. Electricity consumption at integrated plants is dominated by the raw meal and finished cement grinding circuits and, to a lesser extent, by rotating the kiln. In modern dry plants, however, 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 1998, overall consumption of electricity per ton of cement decreased slightly compared with that in 1997, but the change may not be statistically significant. Changes of this small magnitude could be from changes at just a few plants, such as the installation of more modern equipment, a change in the feed or product types (for example, a Type III portland cement needs to be more finely ground than a Type I or II), or the need to estimate some of the data.

Per-ton electricity consumption by dedicated grinding plants showed a small increase in 1998; if statistically significant, this change could reflect the fact that some of these facilities also grind granulated blast furnace slag; slag is harder than clinker, and requires finer grinding. The grinding plant average was about 48% of the overall unit consumption by integrated plants, which is higher than the consumption by the equivalent components (finish milling, conveying, packaging, storage, and loading circuits) at an integrated plant. The higher unit consumption would appear to reflect the fact that the dedicated grinding plants contain ancillary functions (raw materials unloading, storage, conveying, administrative) that, functionally, would be more broadly distributed at an integrated plant.

Consumption

Consumption of cement is shown as an apparent consumption statistic in table 1, and as sales to final customers in tables 9 and 10. Apparent consumption is a mass balance among production; imports, which were adjusted to remove clinker imports, as the production includes cement made from imported clinker; exports; and changes in yearend cement stockpiles. As noted above in the Production section, yearend stockpiles have little meaning, and so the sensitivity of apparent consumption to stockpiles degrades the usefulness of the statistic. For consistency, beginning year stockpiles have been set as equal to the preceding yearend inventory, but this is not always in accord with the actual survey data for January 1 stocks. Another problem is that the trade data used are from the Bureau of the Census and are for all forms of hydraulic cement and clinker, not just for portland and masonry cements, although these two cement types would dominate the data; data specific to masonry cement are unavailable. Also, apparent consumption includes cement moving in inter- and intra-cement-company shipments; that is, material that has yet to be consumed. Nonetheless, apparent consumption is a standard statistic, useful for comparing consumption of cement to that of many other commodities. As noted in the Introduction, apparent consumption of portland plus masonry cement rose 7.8% in 1998 to 103.5 Mt.

Another measure of consumption and the one preferred by the cement industry for its market analyses is that of cement sales or shipments to final customers. Shipments from one cement producer to another are not counted; the materials are considered to have been sold when the receiving cement producer transfers it to a final customer. Likewise, shipments between plants and terminals within a single company are not counted. The definition of who/what 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 or might resell cement to other users. No data on such storage or transfers are available, but they are believed to be small, probably no more than 5% of any single month's shipments, and would likely balance out over a period of months.

The USGS collects data monthly on the shipments of cement to final customers by State of destination and by State or country of origin; that is, manufacture. The monthly destination data are the best available for cement consumption in the United States and are shown totaled for 1997 and 1998 in tables 9 and 10. The annualized portland data listed for 1998 include data for blended cements; these are listed separately on the 1998 monthly surveys themselves. Because this split was not done prior to 1998, the 1997 monthly portland data were already inclusive of blended cements.

Tables 11 through 16 list various data on or derived from shipments of cement reported by cement producers and import terminals as canvassed in the annual surveys. Some of the data, especially those in tables 12 and 13, look superficially similar to the data in tables 9 and 10, but there are important differences between the two data sets, particularly for portland cement. Table 9 lists total portland cement shipments (consumption) of 92.815 Mt in 1997 and 99.272 Mt in 1998, whereas table 13 shows portland cement shipments of 86.692 Mt and 92.809 Mt for the same years, respectively. The difference (6.1 to 6.5 Mt/yr) is similar to those found in earlier years, and would appear to be caused by the different nature of the two types of surveys, as noted in the introduction. As explained there, the larger, more complete, portland cement volumes shown in tables 9 and 10 are preferred as a measure of true consumption. No attempt has been made to impose table 9 and 10 national portland cement totals on the other tables. Agreement between national totals for masonry cement in the two data sets (tables 9 and 13) appears to be close, probably reflecting the relatively (compared to portland) small volumes of this material produced and imported.

There is another important difference between the shipments data in table 9 and those in tables 12 and 13. The data in table 9 data are presented on an individual State basis, but some of the data in tables 12 and 13 are grouped on a multi-State basis where needed to conceal proprietary data for individual plants or companies. This precaution is necessary because the data in tables 12 and 13 represent only the activities of plants and terminals within the given State; that is, the regionality reflects the location and activity of the reporting facilities, not where the cement was sold. Proprietary precautions are not required in table 9 because the States are the locations of the consumers, who can receive materials from multiple sources. Sales for States and districts in tables 12 and 13 can include sales to customers in other regions. Revisions for certain 1997 district data in tables 12 and 13 reflect an apportionment of shipments for importers for which district locations could be assigned; these shipments were included within the 1997 national total in the previous edition of the report.

As an example of the difference between the two data sets, Michigan is shown in table 9 as having consumed 3.411 Mt of portland cement from all sources in 1998, and has having shipped, in total, 5.747 Mt to all domestic consuming regions (table 12). Clearly, Michigan was a net exporter of portland cement in 1998. California (northern and southern combined) shows a consumption of 10.245 Mt for the year (table 9), but shipments of only 9.423 Mt (table 12). Clearly, California was a net importer of cement.

National Consumption.—In 1998, consumption of portland cement grew by 7.0% to a new record level of 99.3 Mt, or 101.2 Mt including Puerto Rico, as listed in table 9. The import component of this rose by 32.3% to 18.2 Mt. Masonry cement consumption increased by 13.1% to 4.1 Mt, with only minor imports; as noted in the introduction, this underrepresents true consumption because some masonry cement is made from portland cement at the job site rather than at a plant. This large increase probably represents, in part, improved splitting out by some companies of masonry varieties from the portland cement data.

Construction spending overall increased by 4.7% in 1998 from that of 1997 (revised) to $544.7 billion (1992 dollars), according to Bureau of the Census data quoted by the Portland Cement Association (1999b). Within this total, residential construction grew by 7.8% to $239.2 billion, spurred by a 12.2% increase to $153.9 billion in single-family dwellings. This reflected very low mortgage interest rates; this sector had been stagnant in 1997 compared with 1996 levels. Multifamily housing grew by 4.1% to $19.9 billion in 1998 compared with a 9.1% (revised) growth in 1997. Nonresidential construction grew by 5.6% in 1998 to $148.0 billion. Public construction fell slightly (0.8%) to $120.4 billion, including a similar percentage decline in spending for roads to $37.5 billion. Road (and related construction) was expected to rise significantly in 1999 owing to the 1998 passage of TEA-21, which mandated large increases in highway funds for road repairs and improvements, averaging about 44% per State.

As was the case in 1996 and 1997, growth in overall construction spending in 1998 was substantially less than that in overall cement consumption. In part, this can be attributed to the modest cement price increases over this period (see Values section below) but is mainly due to a higher "penetration rate" of cement in overall construction; that is, more cement is now being consumed per dollar of construction spending than in past years. The source of this increase is not readily apparent, but appears to be a successful outcome of promotional efforts by cement and concrete companies.

As listed in tables 9 and 10, most States and all regions showed consumption increases in 1998, as was the case in 1997. None of the major cement-consuming States showed decreases. The five largest portland-cement-consuming States were, in declining order, Texas, California, Florida, Ohio, and Illinois; this was the same order as in 1997 except for a reversal of the first two States. There were 15 States that showed consumption increases of 10% or more, and a further 12 (including 4 of the top 5 consuming States) had increases of between 5% and 9.9%.

Table 11 lists portland cement shipments to final customers in terms of transportation method. As in previous years, bulk deliveries directly from plants and via terminals by truck continued to dominate deliveries to customers. In contrast, railroad transport was the most important method of shipping cement from plants to terminals. Waterborne shipments increased modestly for deliveries to terminals but almost ninefold for deliveries to customers. Although imported cement barged along the Mississippi River system increased substantially in 1998, the dramatic increase in total waterborne deliveries during the year may reflect poor data for 1997, which showed an almost 90% decrease in levels from 1996.

Values.—The value data listed in tables 12 through 14 are mill net or 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. Because value data are highly proprietary and some companies express misgivings about providing value data of any type, values are not requested for shipments by individual types of portland cement, although the tonnages, by type, are reported and are listed in table 16. No distinction is made between bulk and container (bag) shipments; container shipments would be expected to have higher unit values. Except in table 14, data for white cement have been lumped in with those for gray portland cement. Notwithstanding these obscuring protections, about one-fifth of the respondents did not provide value data for the 1998 survey (a modest improvement from 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.

For integrated plants, the values sought have been "mill net," which can be defined as the (sales) value at, or "free on board" (f.o.b.), the manufacturing plant, including any packaging charges, but excluding any discounts and shipping charges to the final customers. For independent terminals, particularly import terminals, the equivalent statistic sought would be the "terminal net" value. In the case of imports, this would essentially represent the "cost, insurance, and freight" (c.i.f.) value of the imports plus unloading and storage costs plus the terminal's markup.

Given the entrained problems with the value data, readers are cautioned that the values shown, although unrounded, are merely estimates; most especially, the unit value data cannot be viewed as regional shopping prices for cement. The data for portland cement are assumed to be dominated by the values of the Types I and II varieties.

The total ex-plant value of portland cement shipments to final domestic customers listed in table 12 rose by 11.4% to about $7.0 billion in 1998, reflecting a 7.1% sales volume increase and, within the aforementioned data constraints, an average ex-plant unit value increase of 4%. If the average price listed is applied to the larger shipments (consumption) volume listed in table 9, then the 1998 total rises to $7.5 billion. This followed a 3% increase in unit value and about 9% in total value in 1997 relative to 1996.

Given the large increase in consumption, the modest increase in mill net unit value is most likely due to the ready availability of large volumes of inexpensive imported cement and clinker; the average c.i.f. price of imported cement and clinker (combined) fell by 5.1% in 1998 (table 18). Testing the impact of the imports on a regional basis is ambiguous. Although the regional breakouts in table 12, as noted in the Consumption section, reflect the location of the reporting facilities and not the sales, a crude regionality can be construed. Whereas the unit values for independent importers (not otherwise assigned to districts) did fall, all States and districts having major imports showed value increases or at least stagnant prices. The increases were generally slightly less than those in nonimporting districts; the 10.8% increase for southern California is highly anomalous and makes suspect the value data for that district. This supports the conjecture that imports constrained price increases, if only slightly.

Table 13 lists the distribution of masonry cement sales and the values thereof in terms of the location of the reporting facilities. In 1998, the average unit value of sales increased by about 4% to about $98 per ton; total sales increased by 15% to about $397 million. The total value rises only slightly if the tonnage in table 9 is used. The much higher total value and tons sold in 1998 reflect, in part, more accurate reporting of masonry as a cement separate from portland.

Table 14 is a summary of unit values for the country. The data for white cement are to be viewed with caution because of the limited number of producers and importers of this cement and because a significant share of sales to final customers is as (marked up) resales by gray cement companies. Also, there is a larger component of (expensive compared to bulk) package sales. It is likely that the 8.8% drop in "price" shown in 1998 is exaggerated, and probably reflects too high a value in 1997. Unit values for imported white cement calculated from the 1998 data in table 21 are much lower ($102.12 per ton c.i.f.) than those in table 14 and show only a 2.5% drop, overall, from values in 1997.

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. 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 U.S. cities. The 20-city average delivered price in 1998 for Type I portland converts to $85.31 per metric ton, an increase of 2.7% from that of 1997. The average price ranged over the year by only $2.11 per ton, and showed a general increase over the year, ending at $86.02. The $9.80 per ton difference between the average Engineering News Record price and the average unit value in table 12 is an indicator of the approximate delivery charge to final customers; the differential in 1997 was $10.45 per ton. The Engineering News Record specific city data show a number of regional price differences, some of which differ significantly from those listed in table 12. The variations could reflect regional differences in shipping methods and costs. The Engineering News Record prices for some cities covered, however, did not vary at all during the year, thus making the validity of the data questionable. The smaller differential in 1998 could reflect lower transportation charges because fuel prices were generally low during the year but, again, could also reflect poor data. The Engineering News Record 20-city average masonry cement price for the year was $4.74 per bag (literally converts to $149.28 per ton), an increase of 3.5%; the large difference in "price" between this and the average value in tables 13 and 14 is probably a combination of packaging, handling, and delivery charges.

Types of Cement Customer.—Data for 1998 on portland cement shipments to final customers are shown, broken out by customer (user) type and region, in table 15. As with shipments data in table 12, the regional splitouts represent the locations of reporting facilities, not necessarily those of the consumers.

As with the value data, the user-type data must be viewed as crude estimates. The problem is 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 typically would be entered on the form either all under the broad classification header "Concrete products," or under its breakout subheading "Other." Thus, the subheading(s) "Other," intended to capture miscellaneous uses not otherwise broken out, instead misleadingly serve largely as a catchall. Even for companies that track customer user types in detail, the user categories that they use might not match those of the survey. Also, some categories 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" or the "Contractors— road paving" categories. 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. Plants that initially provided inadequate details for user types on the 1998 survey were solicited on a followup basis for additional details, with only modest success. Some of the minor use categories remain questionable and probably underrepresented.

Notwithstanding these limitations, the data clearly indicate that the dominant customer type for portland cement in 1998 continued to be ready-mixed concrete producers, accounting for 75% 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. Most other major user category tonnages were relatively unchanged in 1998, but detailed evaluation is equivocal. Within concrete manufacturers, brick and block makers appear to have consumed 26% more cement in 1998, probably reflecting strong residential construction, as noted in the National Consumption section above. Sales to precast concrete companies fell by 5%, possibly in line with reduced public sector construction and stagnant nonresidential building construction; likewise, pipe manufacturers took about 2% less cement than in 1997. Within the "Contractors" category, sales to airport pavers fell by 3%, and soil cement usage fell by 16%; both of these are in line with reduced public sector construction. Road paving contractors, however, purchased 14% more cement than in 1997, which, despite lower public sector spending, may reflect a strong improvement in market penetration (vs. asphalt), or the data may simply be an artifact of overlap with the "Ready-mixed concrete" category. Cement sold to oil well drillers fell by about 24%, which is in line with low levels of drilling and low crude petroleum prices in 1998, but may understate cement use for this activity because shallow wells can use ordinary grades of portland cement. Mining usage of cement increased by 11%, which would support a trend, particularly in gold mining, towards more underground operations; cement is used in backfilling of stopes. The potential error in the mining use data is high because of the small tonnages involved. Use of cement for waste stabilization showed a 13% decline, but this would appear to reflect poor data rather than a real drop; consumption for waste stabilization in 1997 may have been anomalously high; it was double the level shown in 1996. Usage is unlikely to vary by this much from year to year.

Types of Portland Cement Consumed.—Portland cement consumption in the United States in 1998 continued to be dominated by general-use varieties, namely Types I and II (table 16). Types I through V again accounted for about 96% of total portland cement, as broadly defined. Type V cement again showed a large increase in sales. Block cement sales rose by 17%, which is in line with higher levels of residential construction spending, but the increase is proportionately less than that for total cement sales to brick and block makers (table 15); the latter data are subject to significant error, however. Oil well cement sales fell sharply in accord with declines in reported total cement sales to oil well drillers.

For the 1998 survey, table 16 has been expanded to split out two extra classes of blended cements, with subtotals shown corresponding to the 1997 and earlier combined categories. Additional categories were actually queried, but insufficient sales tonnages were registered for these to allow their separate listing, for proprietary reasons. Overall, the amount of blended cements sold in 1998 increased by 17.5% to 1.1 Mt and is close to the 1.2 Mt of sales reported for 1998 in the monthly data published separately by the USGS (e.g. table 2a in van Oss, 1999). Monthly sales data for blended cements were not collected for 1997; the data were within the portland cement umbrella.

In recent editions of this report, a comparison of raw materials consumption (broken out in less detail than in the 1998 survey) with the sales data by type of cement led to the conclusion that all or most “blast furnace” slag consumption was for blended cement. Blast furnace slag blended cement was assumed to make up the bulk of the relevant blended sales category. However, comparison of raw materials consumption data in table 6 with sales data in table 16 shows that, for 1998, not only were slag blends only 37% of the hitherto combined blended category (the remainder of which was natural pozzolan blends), but the amount of slag blended cement sales was too small to accommodate the slag consumed. As noted in the raw materials discussion above, it turns out that much of the granulated blast furnace slag was consumed as a grinding aid or as other extender for Types I and II portland cement and was not used in blended cement. This practice probably was not new in 1998.

Combined sales of fly ash and other blended cements more than doubled in 1998, but only 65% of the 1998 sales were of fly ash blends. Earlier, the fly ash proportion of blended sales was assumed to be higher, on the basis of a large excess of fly ash consumed as raw material over what could be accommodated in the blended cement sales; about 25% to 35% of this ash probably was, in fact, bottom ash for pre-1998 data (table 6). This excess also led to the conclusion that most of the fly ash was therefore used as a kiln feed, and the 1998 data supports this. A determination cannot as yet be made whether or not fly ash blended cement sales are increasing; in any case, as was noted above, the bulk of fly ash sales are directly to concrete manufacturers and are thus invisible to the USGS annual cement survey.

Foreign Trade

Trade data from the Bureau of the Census are shown in tables 17 through 22. Exports of hydraulic cement (all types) and clinker, combined, decreased slightly in volume and increased slightly in value (table 17), but the overall volume of exports continued to be so small as to render such small shifts almost meaningless. The bulk of the exports were again to Canada.

Tables 18 and 19 list total imports of hydraulic cement and clinker for 1997 and 1998. Overall, imports rose by almost 37% in 1998 to about 24.1 Mt, including Puerto Rico, and accounted for almost 23% of total cement consumption. This trade was all the more remarkable given the fact that it followed a 24.3% increase in 1997. After rising by 2.7% in 1997, the overall unit value fell by 5.1% in 1998, reflecting substantial price decreases from most country sources. Table 19 lists the tonnages and values of combined cement and clinker imports by source country and Customs District of entry into the United States.

In 1998, the hydraulic cement component of imports (combination data in table 18 minus clinker imports from table 22) was almost 20 Mt, up 36.9%. Gray portland cement imports, which were 95% of this cement total, were up 35.7% (table 20). The average c.i.f. value of gray portland imports in 1998 was $48.70 per ton, down 2.7%, and ranged from $36.36 per ton for Thailand portland cement to $55.01 per ton for Colombian material; Mexican cement had a c.i.f. value of $38.86 per ton. The comparable customs values were $27.91 per ton (Thailand), $28.81 per ton (Mexico), and $44.27 per ton (Colombia). At 3.75 Mt (down 8%), Canada continued to be the largest import source of portland cement. Imports from China, which had been a growing, but still relatively minor overall component of total imports prior to 1998, more than quadrupled to 3.3 Mt in 1998. Imports from Mexico grew by almost 28%, despite continued antidumping tariffs on cement from that country. Cyprus, the Republic of Korea, Saudi Arabia, and Thailand all shipped significant amounts of cement into the United States in 1998 compared with none in 1997. Imports from most other countries also grew substantially.

White portland cement imports increased by about 25% (table 21), but the volumes remained a small component of total cement trade. The average unit value (c.i.f.) of white cement imports fell by 2.5% on average to $102.12 per ton. The total tonnage shown for 1998 (0.649 Mt) is much smaller than the 0.846 Mt monthly summation published previously (table 6 in van Oss, 1999). This is because the monthly data, at that time, included significant volumes of Canadian white cement entering the Cleveland Customs District (0.197 Mt for the year). When registering this material with U.S. Customs, the importer mistakenly used the white cement tariff code rather than the correct gray portland tariff code. Table 21 lists the correct volume of Canadian white cement imports. The major import sources of white cement continued to be Canada, Denmark, Mexico, and Spain.

Clinker imports rose by almost 37% to 4.1 Mt (table 22). Canada continued to be the largest source of imported clinker, with a 40% (import) market share; import tonnages increased by almost 63%. Imports from China were up dramatically to almost 0.2 Mt, but even more impressive was the appearance of 0.5 Mt from Thailand and about 0.2 Mt from the Republic of Korea; neither had been a source in 1997. The overall unit values of imported clinker fell by 16% (c.i.f.) to 19% (Customs) from their respective levels in 1997.

Imported cement and clinker prices were both down, from most sources and into most Customs Districts (table 19). In most regional markets, the price drops can be explained in terms of substantial surplus global cement and clinker capacity, generally low oceanic transportation costs, and a strong U.S. dollar. Even ahead of the late 1997 economic collapse in Southeast Asia, several countries in that region had excess production capacity, some of which had been built for the export market. Throughout 1998, large volumes of Southeast Asian and Chinese cement came onto the world market. Excess capacity for export was also available in Western Europe and in the Mediterranean and the Arabian Gulf regions. However, the large drops seen in unit prices for imported

Canadian clinker (about 30%) and, to some degree, cement (10%), are less obviously explained, because, with the exception of the Pacific Northwest, the major U.S. markets (Buffalo, Cleveland, Detroit) for Canadian material are relatively insulated from offshore competition, and much of the imports are by companies having production facilities in both countries. Local demand on the Ontario market was strong in 1998, leading to reduced Canadian surplus clinker available for export to the United States. Canadian clinker bound for Detroit appears to have been supplemented by inexpensive European and Thailand clinker (see table 19), which did not enter the United States cheaply because it was transshipped via Canada. Part of the Canadian price drop may be explained by the 7% depreciation of the Canadian dollar against the U.S. dollar in 1998, and the remainder could have been due to artificial or transfer pricing by some companies.

Examination of table 19 shows that the major increases in total imports were unevenly distributed regionally; some of the increases can be attributed to the opening or upgrading of terminals. Of note were large increases coming into the Charleston, Detroit, Houston-Galveston, Los Angeles, New Orleans, Philadelphia, San Diego, and San Francisco Customs Districts. New Orleans brought in both the most imports and showed the largest increase (of almost 100%) in 1998 of all Customs Districts. Imports into New Orleans included major increases in volumes from China and Thailand, in particular. Large quantities of cement and/or clinker from the Republic of Korea and/or Thailand were major components of imports into Houston-Galveston, Mobile, and Philadelphia Customs Districts. On the West Coast, large volumes of Chinese cement were displacing some Colombian, Mexican, and Spanish material, and imports into California from Thailand also became important during the year.

World Review

Individual country cement production data are listed in table 23. The data for some countries may include their exports of clinker. Although the data are supposed to include all forms of hydraulic cement, the data for the United States are for portland plus masonry cement only, and the data for some other countries also may not be all inclusive. Because data for many countries are estimated, the annual world totals (which have been rounded) must be viewed as estimates. World hydraulic cement production declined by approximately 1% in 1998, but was still about 1.5 Gt.

China again was overwhelmingly the largest cement producer in the world, with about one-third of the total. Because of a major drop in output by Japan, the United States moved into apparent second place, followed by India (annual output estimated on the basis of reported fiscal year data ending midyear and so could have actually exceeded the United States in 1998). A ranking of the remaining top 15 producers would be, in descending order, Japan, the Republic of Korea, Brazil, Turkey, Germany, Italy, Thailand, Spain, Mexico, Russia, Indonesia, and Taiwan. The top 15 countries accounted for about 74% of the world total, and among these, about a dozen have accounted for the majority of growth in world production in the 1990's. China's growth, in particular, has been dramatic for the years covered in table 23, increasing its output by 92 Mt between 1994 and 1998. Based on preliminary data for 1998, the increase of only 1.8 Mt may reflect incomplete reporting. In the 1997 edition of this report, China's output for 1997 was reported to be 492.6 Mt, up only 1.4 Mt from the level in 1996. The 1997 datum now shows a large upwards revision of 19 Mt, and the 1998 value probably will be revised sharply upwards too.

On a regional basis, Asia (including Australasia) accounted for 57% of the world total, and its 13% growth in production between 1994 and 1998 has accounted for about 74% of the 149-Mt total increase in world production for the period. Because of the economic crisis that began in late 1997, however, major halts, delays, and cancellations of construction projects occurred throughout much of the region, particularly in Southeast Asia. In 1998, cement production in Asia overall fell by about 4% to 870 Mt, but this was buffered by the large increase in China. Without China, Asian production fell by almost 10% to 357 Mt; this included major declines in most of the major producing countries, most of which had been rapidly expanding their production capacities in recent years. For example, cement production declined by 22.4% in the Republic of Korea, an estimated 20% in Indonesia, almost 20% in Thailand, almost 18% in Malaysia, 11.5% in Japan, and about 9% each in the Philippines and Taiwan. Even the reduced production levels exceeded regional demand, with the result that large volumes of Asian cement and clinker were put onto the world market, seemingly, by every cement company that could find access to shipping. This material appears to have caused significant price reductions or at least constrained price increases for cement throughout much of the import-sensitive world, including the United States. It also had the effect of making cash-strapped Asian cement companies attractive acquisition targets of major, mostly European, international cement corporations.

In 1998, Europe was the world's second largest producing region, with 15% of the world total; Western Europe alone had 12%. Western Europe's output grew by 3% between 1994 and 1998, whereas Eastern Europe's output increased by only 1.6%, for the period. North America was the third largest producing region, with 8% of world output in 1998; cement output rose by 5% between 1994 and 1998. The Middle East (including Turkey) had almost 7% of total world production in 1998, up by almost 12% over that of 1994. Latin America accounted for 6% of total world output in 1998, and has been the fastest growth area in the world (38% between 1994 and 1998). Although only contributing 4% of world production, Africa has had a 14% increase in its output during the period. Cement production in Africa, however, is very unevenly distributed, with North African countries accounting for most of the activity and growth. Countries of the former Soviet Union contributed only about 3% of world cement output in 1998, and output fell significantly (by 32%) between 1994 and 1998.

Comparisons 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, etc., cements from modern rotary kilns are preferable. Unfortunately, few if any data on world production are available that differentiate between output of vertical shaft kiln plants and modern rotary kiln plants. Vertical shaft clinker kilns 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 with shaft kilns are replacing them with rotary kilns. For example, China has several thousand small vertical shaft kilns and a much smaller (but still large) number of medium and large rotary kilns. The rotary kilns were contributing only about 15% of the country's total output, but this material was the entirety of China's production of high- or export-quality cement. The Government of China was shutting down a large number of the vertical shaft kiln plants for environmental reasons and to reduce the country's surplus capacity, thereby reducing downward pressures on cement prices (Tang, 1999).

Notwithstanding the Asian economic crisis, a large number of cement plant construction or upgrade projects continued underway in that region, and similar projects were common in most other regions as well. The privatization programs in Eastern Europe and elsewhere have attracted investment interest mainly by the same major European and Mexican cement companies that dominate the production of cement in Western Europe, the former Soviet Union, and the Americas.

Outlook

Demand for cement in the United States was expected to remain strong in 1999, with consumption growth rates at, or perhaps slightly below, levels in 1998. Interest rates were expected to rise somewhat, which likely would constrain growth in housing construction, but this was expected to be more than overcome by higher spending for public sector projects, particularly highway projects related to the TEA-21 program. Medium-to-long-term growth in cement annual consumption was expected, overall, to be between 2% and 4%.

One new plant was expected to come into full production in late 1999, and several million tons of new production capacity were slated to come on line (mostly as upgrades at existing plants) over the next few years. The added production capacity would likely result in some reduction in imports. Domestic producers were expected to maintain their overall control of cement imports.

Although the potential duration of the economic crisis in Southeast Asia was not known, a resurgence of major construction projects in the region was not expected over the short to medium term, and thus the region was expected to have substantial excess cement production capacity available for export for several years. Imports of inexpensive Asian cement and/or clinker into the United States were expected to increase as a result, and some of this was expected to be at the expense of imports from Europe and South America. Imports of cement and clinker from Mexico and Venezuela were expected to increase significantly if the antidumping tariffs or related pricing agreements affecting those countries were not renewed following "sunset" review; citing the strong U.S. cement market and the substantial control on imports held by U.S. producers, one major company announced that it would no longer support the continuation of antidumping tariffs (Southdown, Inc., 1999b). Given recent reductions in production capacity in Japan, a resumption of significant imports from that country was uncertain if the antidumping tariffs were dropped.

Apart from market factors, future growth of U.S. cement production or capacity may be constrained by restrictive environmental regulation, particularly any that seeks to limit output of CO_2, or that hinder the ability of the industry to utilize waste fuels.

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TABLE 1
SALIENT CEMENT STATISTICS 1/

(Thousand metric tons, unless otherwise specified)

	1994	1995	1996	1997	1998
United States 2/					
Production 3/	77,948	76,906	79,266	82,582	83,931
Production of clinker	68,575	69,983	70,361	72,686	74,523
Shipments from mills 3/ 4/	79,087	78,518	83,963 r/	90,490 r/	96,857
Value 3/ 5/ thousands	$4,844,869	$5,329,187	$5,952,203	$6,622,464	$7,404,094
Average value per ton 3/ 6/	$61.26	$67.87	$71.19	$73.49	$76.46
Stocks at mills, yearend 3/	4,701	5,814	5,488	5,784	5,393
Exports 3/ 7/	633	759	803	791	743
Imports for consumption:					
Cement 8/	9,074	10,969	11,565	14,523	19,878
Clinker	2,206	2,789	2,402	2,867	3,905
Total	11,280	13,758	13,967	17,389	23,783
Consumption, apparent 9/	86,476	86,003	90,355	96,018	103,457
World: Production 10/	1,370,000 r/	1,444,000 r/	1,493,000 r/	1,540,000 r/	1,519,000

r/ Revised.
1/ Portland and masonry cements only, unless otherwise indicated.
2/ Excludes Puerto Rico.
3/ Includes cement produced from imported clinker and 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 9 and 10, which are based on consolidated monthly shipments data from companies.
5/ Value at mill (or import terminal) of portland (all types) 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
COUNTY BASIS OF SUBDIVISION OF STATES IN CEMENT TABLES

State subdivision	Defining counties
California, northern	Alpine, Fresno, Kings, Madera, Mariposa, Monterey, Tulare, Tuolumne, and all counties further north.
California, southern	Inyo, Kern, Mono, San Luis Obispo, and all counties further south.
Chicago, metropolitan	Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will Counties in Illinois.
Illinois	All counties other than those in Metropolitan Chicago.
New York, eastern	Delaware, Franklin, Hamilton, Herkimer, Otsego, and all counties further east and south, excepting those within Metropolitan New York.
New York, western	Broome, Chenango, Lewis, Madison, Oneida, St. Lawrence, and all counties further west.
New York, metropolitan	New York City (Bronx, Kings, New York, Queens, and Richmond), Nassau, Rockland, Suffolk, and Westchester.
Pennsylvania, eastern	Adams, Cumberland, Juniata, Lycoming, Mifflin, Perry, Tioga, Union, and all counties further east.
Pennsylvania, western	Centre, Clinton, Franklin, Huntingdon, Potter, and all counties 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, Ward, and all counties further north.
Texas, southern	Burnet, Crockett, Jasper, Jeff Davis, Llano, Madison, Mason, Menard, Milam, Newton, Pecos, Polk, Robertson, San Jacinto, Schleicher, Tyler, Walker, Williamson, and all counties further south.

TABLE 3
PORTLAND CEMENT PRODUCTION, CAPACITY, AND STOCKS IN THE UNITED STATES, BY DISTRICT 1/ 2/

(Thousand metric tons, unless otherwise specified)

District	1997 Plants active 5/	1997 Production 6/	1997 Capacity 3/ Finish grinding	1997 Capacity 3/ Percentage utilized	1997 Stocks 4/ at mills, yearend	1998 Plants active 5/	1998 Production 6/	1998 Capacity 3/ Finish grinding	1998 Capacity 3/ Percentage utilized	1998 Stocks 4/ at mills, yearend
Maine and New York	4	3,147	3,529	89.2	242	4	3,236	3,756	86.2	215
Pennsylvania, eastern	7	4,501	5,084	88.5	236	7	4,782	5,156	92.7	185
Pennsylvania, western	4	1,858	2,045	90.8	129	4	1,952	2,168	90.0	130
Illinois	4	2,594	3,399	76.3	194	4	2,691	3,204	84.0	106
Indiana	4	2,396	2,731	87.8	167	4	2,500	2,840	88.0	127
Michigan	5	5,696	7,243	78.6	287	5	5,707	6,980	81.8	325
Ohio	3	1,043	1,878	55.5	56	2	1,113	1,515	73.4	52
Iowa, Nebraska, South Dakota	5	4,224	5,525	76.4	354	5	4,241	5,531	76.7	303
Kansas	4	1,690	1,783	94.8	134	4	1,802	1,805	99.8	84
Missouri	5	4,731	5,150	91.9	404	5	4,569	5,186	88.1	404
Florida	6	3,747	5,262	71.2	293	6	3,472	5,334	65.1	207
Georgia, Virginia, West Virginia	4 r/	2,577	3,277	78.7	242	4	2,734	3,382	80.8	110
Maryland	3	1,790	1,904	94.0	133	3	1,756	1,837	95.6	82
South Carolina	3	2,515	3,075	81.8	93	3	2,640	3,311	79.7	81
Alabama	5	4,279	4,744	90.2	275	5	4,305	4,990	86.3	219
Kentucky, Mississippi, Tennessee	4	2,316	2,528	91.6	157	4	2,364	2,574	91.9	132
Arkansas and Oklahoma	4	2,714	3,162	85.8	149	4	2,598	3,162	82.2	175
Texas, northern	6	3,887	4,719	82.4	208	6	4,114	4,742	86.8	272
Texas, southern	5	4,393	4,772	92.1	204	5	4,319	4,781	90.3	167
Arizona and New Mexico	3	2,239	2,563	87.4	64	3	2,240	2,563	87.4	48
Colorado and Wyoming	4	2,018	2,445	82.5	100	4	2,138	2,445	87.4	163
Idaho, Montana, Nevada, Utah	7	2,344	2,926	80.1	168	7	2,605	3,196	81.5	218
Alaska and Hawaii	1	252	499	50.5	52	1	251	499	50.2	40
California, northern	3	2,773	2,797	99.1	115	3	2,768	2,835	97.6	125
California, southern	8	7,488	7,957	94.1	313	8	7,249	7,888	91.9	306
Oregon and Washington	4	1,737	2,204	78.8	99	4	1,796	2,491	72.1	207
Total or average 7/	115 r/	78,948	93,198	84.7	5,356 8/	114	79,942	94,170	84.9	4,981 8/
Puerto Rico	2	1,673	2,004	83.5	31	2	1,591	1,831	86.9	24

r/ Revised.
1/ Includes Puerto Rico.
2/ Includes data for three white cement facilities located in California, Pennsylvania, and Texas.
3/ Reported grinding capacity based on fineness necessary to grind individual plants' normal product mix, making allowance for downtime required for routine maintenance.
4/ Includes imported cement.
5/ Includes one plant that reported portland cement (clinker) grinding capacity, but no production of portland cement.
6/ Includes cement produced from imported clinker.
7/ Data may not add to totals shown because of independent rounding.
8/ Total stocks include inventory, not included on a district basis, held by independent importers.

TABLE 4
MASONRY CEMENT PRODUCTION AND STOCKS IN THE UNITED STATES, BY DISTRICT 1/

(Thousand metric tons, unless otherwise specified)

District	1997 Plants active	1997 Production 3/	1997 Stocks 2/ at mills, yearend	1998 Plants active	1998 Production 3/	1998 Stocks 2/ at mills, yearend
Maine and New York	4	107	16	4	108	14
Pennsylvania, eastern	6	187	33	6	202	27
Pennsylvania, western	4	109	14	4	117	16
Indiana	4	W	54	4	W	46
Michigan	5	289	29	5	294	42
Ohio	2	W	W	2	W	W
Iowa, Nebraska, South Dakota	4	W	10	4	W	10
Kansas	3	W	W	3	W	W
Missouri	1	W	W	1	W	W
Florida	4	406	24	4	442	25
Georgia, Virginia, West Virginia	5	382	38	5	343	29
Maryland	3	W	13	3	W	12
South Carolina	3	W	W	3	W	W
Alabama	4	346	48	4	371	44
Kentucky, Mississippi, Tennessee	3	88	9	3	90	10
Arkansas and Oklahoma	4	105	14	4	126	15
Texas, northern	4	110	10	4	124	8
Texas, southern	4	94	8	4	93	8
Arizona and New Mexico	3	W	W	3	W	W
Colorado and Wyoming	2	W	W	2	W	W
Idaho, Montana, Nevada, Utah	2	W	2	2	W	1
Alaska and Hawaii	1	3	1	1	3	1
California, northern	2	W	W	2	W	W
California, southern	3	W	W	3	W	W
Oregon and Washington	3	W	W	3	W	W
Total 4/	83	3,634 5/	428 6/	83	3,989 5/	412 6/

W Withheld to avoid disclosing company proprietary data; included in "Total."

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

2/ Includes imported cement.

3/ Includes cement produced 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 almost 94% of the total. Production from portland cement accounted for the remainder.

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

TABLE 5
CLINKER CAPACITY AND PRODUCTION IN THE UNITED STATES IN 1998, 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 mainte-nance	Apparent annual capacity 2/ (thousand metric tons)	Produc-tion (thousand metric tons)	Percentage utilized
Maine and New York	3	1	--	4	5	10.4	34.2	3,442	3,109	90.3
Pennsylvania, eastern	2	5	--	7	14	14.8	23.9	4,973	4,456	89.6
Pennsylvania, western	3	1	--	4	8	5.9	24.4	2,012	1,834	91.1
Illinois	--	4	--	4	8	8.3	24.4	2,818	2,474	87.8
Indiana	2	2	--	4	8	8.5	21.6	2,903	2,577	88.8
Michigan	1	2	--	3	8	13.6	21.6	4,633	4,201	90.7
Ohio	1	1	--	2	3	3.3	20.3	1,129	1,016	90.0
Iowa, Nebraska, South Dakota	--	4	1	5	9	13.6	27.8	4,587	4,021	87.7
Kansas	2	2	--	4	11	5.6	30.5	1,865	1,672	89.7
Missouri	2	3	--	5	7	14.0	23.9	4,723	4,472	94.7
Florida	2	2	--	4	7	9.3	23.7	3,146	2,952	93.8
Georgia, Virginia, West Virginia	1	3	--	4	7	9.4	28.9	3,153	2,602	82.5
Maryland	1	2	--	3	7	5.6	23.1	1,898	1,682	88.6
South Carolina	2	1	--	3	7	8.3	26.0	2,728	2,315	84.9
Alabama	--	5	--	5	6	13.2	24.0	4,414	4,180	94.7
Kentucky, Mississippi, Tennessee	2	2	--	4	5	6.6	19.6	2,288	2,235	97.7
Arkansas and Oklahoma	2	2	--	4	10	7.7	21.8	2,632	2,503	95.1
Texas, northern	3	3	--	6	14	13.1	27.5	4,385	4,039	92.1
Texas, southern	--	4	1	5	6	12.9	20.5	4,453	4,033	90.6
Arizona and New Mexico	--	3	--	3	9	6.5	18.4	2,266	2,184	96.4
Colorado and Wyoming	1	3	--	4	7	6.9	25.3	2,337	1,959	83.8
Idaho, Montana, Nevada, Utah	3	4	--	7	9	8.5	21.0	2,947	2,505	85.0
California, northern	--	3	--	3	3	8.7	36.0	2,849	2,632	92.4
California, southern	--	8	--	8	17	24.0	23.2	8,142	7,332	90.1
Oregon and Washington	1	2	--	3	3	5.9	26.3	1,997	1,537	77.0
Total or average 3/	34	72	2	108	198	244.4	24.7	82,718	74,523	90.1
Puerto Rico	--	2	--	2	2	5.0	30.0	1,671	1,319	78.9

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 6
RAW MATERIALS USED IN PRODUCING CEMENT
IN THE UNITED STATES 1/ 2/ 3/

(Thousand metric tons)

Raw materials	1997 total 4/	1998 Clinker	1998 Cement
Calcareous:			
Limestone (includes aragonite, marble, chalk, coral)	84,423 r/	87,077	707 5/
Cement rock (includes marl)	25,704	22,642	W
Cement kiln dust	NA	196 6/	W
Lime	NA	--	16 5/
Aluminous:			
Clay	4,434	4,513	--
Shale	4,010	3,726	--
Other (includes staurolite, bauxite, aluminum dross, alumina, volcanic material, other)	323	443	--
Ferrous: iron ore, pyrites, millscale, other	1,452	1,253	--
Siliceous:			
Sand and calcium silicate	2,322	2,834	--
Sandstone, quartzite, other	775	860	--
Fly ash	1,544 r/	1,432	99
Other ash, including bottom ash	523 7/	793	--
Granulated blast furnace slag	460 8/	--	285
Steel slag	NA 8/	307	--
Other slags	NA 8/	75	(9/)
Natural rock pozzolans 10/	NA 11/	--	52
Other pozzolans 12/	NA 11/	43	1
Other:			
Gypsum and anhydrite	4,274	--	4,408
Clinker, imported 13/	2,585	--	5,016
Other, n.e.c.	35	369	57
Total 14/	132,865	126,563	10,641

r/ Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Other: Other, n.e.c."
1/ Includes Puerto Rico.
2/ Nonfuel materials only.
3/ Includes portland, blended, and masonry cements.
4/ Data for the breakout of consumption between clinker and finished cement manufacture are unavailable for years prior to 1998.
5/ Data are probably underreported on the basis of reported volumes of masonry cements.
6/ Data are probably underreported.
7/ Bottom ash only. Other ash not queried specifically, but included in fly ash.
8/ Not queried separately in 1997, but included within blast furnace slag.
9/ Less than 1/2 unit.
10/ Includes pozzolana, burned clays, and shales.
11/ Not queried in 1997, but some may have been included under aluminous materials.
12/ Includes diatomite, other microcrystalline silica, silica fume, and other pozzolans, whether or not used as such.
13/ Outside purchases by domestic plants; excludes purchases of domestic clinker.
14/ Data may not add to totals shown because of independent rounding.

TABLE 7
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)
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 4/	351	1,288	86,235	672,345	277	68	835,179
1998:											
Wet	34	18,905	24.9	2,536	122	323	23,443	174,974	86	52	1,172,357
Dry	74	55,481	73.2	6,305	310	853	49,483	456,429	171	23	95,809
Both	2	1,457	1.9	226	--	21	--	88,765	12	--	--
Total 3/	110	75,842	100.0	9,066 4/	432	1,197	72,926	720,168	269	74	1,268,166

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.
4/ Virtually all bituminous.

TABLE 8
ELECTRIC ENERGY USED AT CEMENT PLANTS IN THE UNITED STATES, BY PROCESS 1/

	Electric energy used							
	Generated at plant		Purchased		Total			
Plant process	Number of plants	Quantity (million kilowatt-hours)	Number of plants	Quantity (million kilowatt-hours)	Quantity (million kilowatt-hours)	Percentage	Finished cement 2/ produced (thousand metric tons)	Average consumption (kilowatt-hours per ton of cement produced)
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 or average 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	--
1998:								
Integrated plants								
Wet	--	--	34	2,831	2,831	23.6	21,296	133
Dry	4	496	74	8,421	8,917	74.4	60,221	148
Both	--	--	2	242	242	2.0	1,584	153
Total or average 3/	4	496	110	11,494	11,990	100.0	83,101	144
Grinding plants 4/	--	--	5	142	142	--	2,275	69
Exclusions 5/	--	--	2	--	--	--	145	--

1/ Includes Puerto Rico.
2/ Includes portland and masonry cements. 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 of masonry cement only. One of these plants reports portland cement grinding capacity and so is included in table 3.

TABLE 9
CEMENT SHIPMENTS TO FINAL CUSTOMER, BY DESTINATION AND ORIGIN 1/ 2/

(Thousand metric tons)

Destination and origin	Portland cement 1997	Portland cement 1998	Masonry cement 1997	Masonry cement 1998
Destination:				
Alabama	1,425	1,503	137	144
Alaska	107	121	W	--
Arizona	2,563	2,921	W	99
Arkansas	1,009	1,050	54	56
California, northern	3,587	3,896	13	49
California, southern	5,883	6,349	W	300
Colorado	2,013	2,358	25	27
Connecticut 3/	690	751	13	14
Delaware 3/	247	287	10	11
District of Columbia 3/	105	98	1	--
Florida	6,435	6,887	536	570
Georgia	3,225	3,535	237	265
Hawaii	251	256	3	4
Idaho	473	488	1	(4/)
Illinois, excluding Chicago	1,525	1,539	33	32
Chicago, metropolitan 3/	1,995	2,105	49	48
Indiana	2,140	2,260	96	99
Iowa	1,739	1,759	12	11
Kansas	1,508	1,530	15	16
Kentucky	1,328	1,320	98	101
Louisiana 3/	1,820	1,912	50	54
Maine	187	235	5	5
Maryland	1,225	1,216	80	79
Massachusetts 3/	1,262	1,562	24	26
Michigan	3,201	3,411	153	161
Minnesota 3/	1,693	1,887	30	31
Mississippi	968	963	53	58
Missouri	2,311	2,359	40	39
Montana	303	314	1	1
Nebraska	1,020	1,060	10	13
Nevada	1,899	1,946	15	29
New Hampshire 3/	263	288	7	7
New Jersey 3/	1,700	1,966	63	71
New Mexico	739	732	7	7
New York, eastern	518	598	23	24
New York, western	879	887	35	38
New York, metropolitan 3/	1,291	1,473	46	50
North Carolina 3/	2,599	2,703	296	323
North Dakota 3/	266	321	4	4
Ohio	3,774	4,002	197	197
Oklahoma	1,188	1,364	43	42
Oregon	1,195	1,145	1	1
Pennsylvania, eastern	1,958	2,169	63	63
Pennsylvania, western	1,124	1,208	70	74
Rhode Island 3/	127	151	3	3
South Carolina	1,200	1,274	125	140
South Dakota	420	372	3	3
Tennessee	2,041	2,108	211	217
Texas, northern	4,543	5,030	150	168
Texas, southern	4,834	5,235	81	93
Utah	1,345 r/	1,493	1	1
Vermont 3/	106	124	3	3
Virginia	1,910	2,002	157	153
Washington	1,862	1,877	5	5
West Virginia	440	430	30	30
Wisconsin	2,129	2,220	37	37
Wyoming	228	221	1	1
U.S. total 5/ 6/	92,815 r/	99,272	3,627	4,101
Foreign countries 7/	349	321	1	1
Puerto Rico	1,670	1,581	--	--
Grand total 5/	94,834 r/	101,174	3,628	4,101

See footnotes at end of table.

TABLE 9--Continued
CEMENT SHIPMENTS TO FINAL CUSTOMER, BY DESTINATION AND ORIGIN 1/ 2/

(Thousand metric tons)

Destination and origin	Portland cement 1997	Portland cement 1998	Masonry cement 1997	Masonry cement 1998
Origin:				
United States	79,395 r/	81,374	3,583	4,043
Puerto Rico	1,670	1,581	--	--
Foreign countries 8/	13,770 r/	18,221	45	58
Total shipments 5/	94,834 r/	101,174	3,628	4,101

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "U.S. total."
1/ Includes cement produced from imported clinker and imported cement shipped by domestic producers and other importers
2/ Data are developed from consolidated monthly surveys of shipments by companies and may differ from data in tables 1, 11, 12, 13, 15, and 16, 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 and other importers.

TABLE 10
CEMENT SHIPMENTS, BY DESTINATION (REGION AND CENSUS DISTRICT) 1/ 2/

Region and census district	Portland cement: Thousand metric tons 1997	Portland cement: Thousand metric tons 1998	Portland cement: Percentage of U.S. total 1997	Portland cement: Percentage of U.S. total 1998	Masonry cement: Thousand metric tons 1997	Masonry cement: Thousand metric tons 1998	Masonry cement: Percentage of U.S. total 1997	Masonry cement: Percentage of U.S. total 1998
Northeast:								
New England 3/	2,634	3,111	3	3	55	58	2	1
Middle Atlantic 4/	7,469	8,302	8	8	301	277	8	7
Total 5/	10,103	11,413	11	11	356	335	10	8
South:								
South Atlantic 6/	17,386	18,432	19	19	1,472	1,571	41	38
East South Central 7/	5,762	5,894	6	6	498	520	14	13
West South Central 8/	13,394	14,591	13	15	378	413	10	10
Total 5/	36,541	38,917	39	39	2,349	2,504	65	61
Midwest:								
East North Central 9/	14,765	15,537	16	16	566	574	16	14
West North Central 10/	8,958	9,288	10	9	114	117	3	3
Total 5/	23,722	24,825	26	25	680	691	19	17
West:								
Mountain 11/	9,563 r/	10,473	14	11	140	165	4	4
Pacific 12/	12,886	13,644	10	14	102	237	3	6
Total 5/	22,449 r/	24,117	24	24	242	402	7	10
U.S. total 5/	92,815 r/	99,272	100	100	3,627	4,101	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, 11, 12, 13, 15, and 16, 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 11

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 shipments to consumer 3/ 4/
	In bulk	In containers 2/	In bulk	In containers 2/	In bulk	In containers 2/	
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
1998:							
Railroad	11,285	38	5,301	380	1,182	(6/)	6,863
Truck	4,118	151	50,845	1,810	32,527	613	85,795
Barge and boat	8,423	--	442	--	900	--	1,342
Other 5/	--	--	153	(6/)	251	2	406
Total 3/	23,826	189	56,742	2,190	34,860	615	94,408

1/ Includes Puerto Rico. Includes imported cement and cement made from imported clinker.

2/ Includes bags and jumbo bags.

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

4/ Shipments calculated on the basis of an annual survey of plants and importers; may differ from tables 9 and 10, which are based on consolidated company monthly data.

5/ Includes cement used at plant.

6/ Less than 1/2 unit.

TABLE 12

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

District 5/ 6/	1997 Quantity (thousand metric tons) 7/	1997 Value 4/ Total (thousands)	1997 Value 4/ Average per metric ton	1998 Quantity (thousand metric tons) 7/	1998 Value 4/ Total (thousands)	1998 Value 4/ Average per metric ton
Maine and New York	2,008 r/	$127,940 r/	$63.72 r/	3,631	$245,768	$67.69
Pennsylvania, eastern	4,454	283,965	63.75	4,916	321,819	65.46
Pennsylvania, western	1,689	121,649	72.04	1,768	131,601	74.43
Illinois	2,590	186,281	71.91	2,726	210,145	77.08
Indiana	2,663	187,076	70.24	2,878	202,334	70.31
Michigan	5,739	425,705	74.18	5,747	437,621	76.15
Ohio	1,107	81,655	73.75	1,196	92,977	77.71
Iowa, Nebraska, South Dakota	4,247	323,321	76.12	4,374	339,304	77.58
Kansas	1,798	129,970	72.28	1,648	126,617	76.83
Missouri	5,563	377,411	67.84	5,889	415,897	70.62
Florida	5,689 r/	405,969 r/	71.36 r/	6,126	456,559	74.53
Georgia, Virginia, West Virginia	2,773	212,006	76.45	2,932	222,079	75.74
Maryland	2,064	132,049	63.98	1,785	124,858	69.95
South Carolina	2,531	194,938	77.02	2,606	207,586	79.66
Alabama	4,103	329,663	80.34	4,375	358,430	81.93
Kentucky, Mississippi, Tennessee	2,911	216,284	74.31	2,624	201,087	76.63
Arkansas and Oklahoma	2,673	185,509	69.40	2,621	190,086	72.53
Texas, northern	4,028	299,071	74.25	4,319	339,463	78.59
Texas, southern	5,141	338,549	65.86	5,364	373,097	69.56
Arizona and New Mexico	2,313	189,424	81.90	3,465	301,763	87.09
Colorado and Wyoming	2,056	163,640	79.60	2,219	181,686	81.87
Idaho, Montana, Nevada, Utah	2,646	213,531	80.71	2,721	229,257	84.26
Alaska, Hawaii, Oregon, Washington	3,084 r/	256,669 r/	83.23 r/	3,102	259,792	83.75
California, northern	2,425	180,158	74.28	2,573	194,317	75.51
California, southern	7,521	503,632	66.96	6,850	508,011	74.16
Independent importers, n.e.c. 8/	2,874	227,196	79.05	4,352	335,423	77.07
Total or average 9/	86,692	6,293,261	72.59	92,809	7,007,577	75.51
Puerto Rico	1,677	W	W	1,599	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 located in 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/ Includes shipments by independent importers where district assignation is possible.

6/ The district location is that of the reporting facility. Shipments may include material sold into other districts.

7/ Shipments calculated on the basis of an annual survey of plants and importers; may differ from tables 9 and 10, which are based on consolidated company monthly

8/ Shipments by importers for which district assignations were not possible.

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

TABLE 13

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

District 5/	1997 Quantity (thousand metric tons) 6/	1997 Value 4/ Total (thousands)	1997 Value 4/ Average per metric ton	1998 Quantity (thousand metric tons) 6/	1998 Value 4/ Total (thousands)	1998 Value 4/ Average per metric ton
Maine and New York	108 r/	$9,404 r/	$87.07 r/	109	$9,538	$87.79
Pennsylvania, eastern	203	20,408	100.30	220	20,892	95.06
Pennsylvania, western	104	11,829	113.92	109	11,219	102.48
Illinois, Indiana, Ohio	498	48,415	97.31	499	49,248	98.77
Michigan	283	23,248	82.17	286	27,222	95.10
Iowa, Nebraska, South Dakota	43	3,644	84.76	51	4,753	94.05
Kansas and Missouri	144	9,387	65.08	132	8,942	67.86
Florida	400 r/	35,951 r/	89.88 r/	426	39,132	91.76
Georgia, Virginia, West Virginia	410	39,009	95.07	367	39,622	108.11
Maryland and South Carolina	424	44,470	104.82	493	56,161	113.86
Alabama	314	32,847	104.44	379	39,972	105.37
Kentucky, Mississippi, Tennessee	97	8,254	85.35	90	7,782	86.15
Arkansas and Oklahoma	108	7,965	73.97	124	9,268	74.60
Texas	184	17,081	93.08	203	19,207	94.79
Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah, Wyoming	130	11,751	90.64	128	12,096	94.44
Alaska and Hawaii	3	354	102.32	3	342	101.95
California, Oregon, Washington	175	14,128 r/	80.73 r/	417	40,393	96.78
Independent importers, n.e.c. 7/	39	6,058	155.33	12	1,029	85.75
Total or average 8/	3,667	344,203	93.87	4,048	396,817	98.03

r/ Revised.

1/ Shipments are to final domestic customers and include shipments of imported cement.

2/ Includes data for three white cement facilities located in 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 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 per ton.

5/ Includes shipments by independent importers where district assignation is possible.

6/ Shipments calculated on the basis of an annual survey of plants and importers; may differ from tables 9 and 10, which are based on consolidated company monthly data.

7/ Shipments by importers for which district assignations were not possible.

8/ Total includes imports shipped by independent importers.

TABLE 14

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
1997	71.85	177.05	72.59	93.87	73.49
1998	74.76	161.40	75.51	98.03	76.46

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 15
PORTLAND CEMENT SHIPMENTS IN 1998, BY DISTRICT AND TYPE OF CUSTOMER 1/

(Thousand metric tons)

District 2/ 3/	Ready-mixed concrete	Concrete product manufacturers 4/	Contractors 5/	Building material dealers	Oil well, mining, waste 6/	Government and miscellaneous 7/	District total 8/ 9/
Maine and New York	2,893	273	364	80	9	20	3,631
Pennsylvania, eastern	3,093	795	593	339	31	66	4,916
Pennsylvania, western	1,232	126	151	8	26	227	1,768
Illinois	1,380	331	151	34	824	6	2,726
Indiana	2,277	410	72	105	12	3	2,878
Michigan	4,420	506	686	112	22	--	5,747
Ohio	792	170	198	31	--	5	1,196
Iowa, Nebraska, South Dakota	3,247	650	328	77	40	32	4,374
Kansas	1,269	137	195	25	16	6	1,648
Missouri	4,323	642	682	194	--	47	5,889
Florida	4,186	1,154	256	464	--	66	6,126
Georgia, Virginia, West Virginia	1,979	588	170	160	14	23	2,932
Maryland	1,253	293	207	17	(10/)	17	1,785
South Carolina	1,973	429	75	74	45	11	2,606
Alabama	3,432	588	149	161	23	21	4,375
Kentucky, Mississippi, Tennessee	2,215	198	167	18	4	21	2,624
Arkansas and Oklahoma	1,883	189	454	30	63	2	2,621
Texas, northern	2,773	407	675	104	313	48	4,319
Texas, southern	4,149	327	558	101	221	7	5,364
Arizona and New Mexico	2,752	319	139	97	44	112	3,465
Colorado and Wyoming	1,733	203	228	31	25	(10/)	2,219
Idaho, Montana, Nevada, Utah	2,158	222	143	30	58	110	2,721
Alaska and Hawaii	269	19	6	17	(10/)	7	318
California, northern	2,013	358	89	111	--	1	2,573
California, southern	4,980	1,056	313	337	117	46	6,850
Oregon and Washington	2,246	260	205	48	8	18	3,102
Total 9/ 11/	69,305	11,125	7,406	3,030	1,051	1,011	92,809
Puerto Rico	854	152	55	536	(10/)	3	1,599

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/ District location is that of the reporting facility. Shipments may include material sold into other districts.
3/ Includes shipments by independent importers, where district assignations were possible.
4/ Shipments to concrete product manufacturers include brick-block--5,126; precast--2,222; pipe--1,464; and other or unspecified--2,469.
5/ Shipments to contractors include airport--492; road paving--4,577; soil cement--1,384 and other or unspecified--1,014.
6/ Shipments to oil well, mining, and waste include oil well drilling--1,052; mining--689; and waste stabilization--180.
7/ Includes shipments for which customer types were not specified.
8/ Shipments calculated on the basis of an annual survey of plants and importers; may differ from tables 9 and 10, which are based on consolidated monthly data.
9/ Data may not add to totals shown because of independent rounding.
10/ Less than 1/2 unit.
11/ Includes imports shipped by independent importers for which district assignations were not possible.

TABLE 16
PORTLAND CEMENT SHIPPED FROM PLANTS IN THE
UNITED STATES TO DOMESTIC CUSTOMERS, BY TYPE 1/ 2/

(Thousand metric tons)

Type	1997	1998
General use and moderate heat (Types I and II), (Gray)	79,312	85,066
High early strength (Type III)	3,109	3,151
Sulfate resisting (Type V)	2,456	2,757
Block	506	594
Oil well	1,229	797
White	634	790
Blended:		
Portland--natural pozzolans	NA	284
Portland--granulated blast furnace slag	NA	165
Total 3/	639	449
Portland--fly ash	NA	438
Other blended cement 4/	NA	234
Total 3/	314	671
Expansive and regulated fast setting	120	53
Miscellaneous 5/	50	79
Grand total 3/	88,368	94,408

NA Not available.
1/ Includes imported cement. Includes Puerto Rico.
2/ Shipments calculated on the basis of an annual survey of plants and importers; may differ from tables 9 and 10, which are based on consolidated company monthly data.
3/ Data may not add to totals shown because of independent rounding.
4/ Includes blends with cement kiln dust and silica fume.
5/ Includes waterproof and low heat (Type IV).

TABLE 17
U.S. EXPORTS OF HYDRAULIC CEMENT AND CLINKER, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country of destination	1997 Quantity	1997 Value 2/	1998 Quantity	1998 Value 2/
Aruba	5	70	6	327
Australia	5	402	5	239
Bahamas, The	8	858	15	1,222
Canada	605	42,106	565	39,205
Dominica	--	--	13	806
Dominican Republic	3	349	5	299
Germany	23	963	15	676
Latvia	8	355	4	145
Mexico	45	5,997	54	6,846
Panama	7	623	15	764
Other	80 r/	7,888 r/	46	6,029
Total 3/	789	59,611	743	56,558

r/ Revised.
1/ Includes portland and masonry cements.
2/ Free alongside ship (f.a.s.) value. The value of exports at the U.S. seaport or border port of export is 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: Bureau of the Census.

TABLE 18

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

(Thousand metric tons and thousand dollars)

	1997			1998		
		Value			Value	
Country of origin	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Australia	83	2,692	4,013	155	3,986	6,663
Belgium	61	2,781	3,723	285	12,438	14,921
Canada	5,350	269,471	293,868	5,957	255,893	286,146
China	610	24,951	32,196	3,489	132,926	168,024
Colombia	906	36,898	47,177	1,165	49,945	61,873
Cyprus	--	--	--	161	6,196	7,844
Denmark	579	24,576	34,993	580	26,126	36,537
France	441	27,157	31,471	361	24,149	28,441
Greece	1,860	68,741	88,620	2,124	83,757	106,183
Italy	401	17,041	21,876	736	26,780	35,252
Korea, Republic of	--	--	--	260	5,576	9,731
Mexico	995	37,804	47,612	1,280	48,518	61,495
Norway	283	10,182	12,906	322	11,867	15,252
Saudi Arabia	--	--	--	185	5,815	8,151
Spain	1,845	75,282	100,988	2,204	94,578	123,737
Sweden	886	28,620	38,437	937	30,389	40,539
Thailand	--	--	--	758	17,989	24,937
Turkey	973	35,805	46,111	1,070	40,324	52,774
United Kingdom	153	7,289	8,700	118	5,814	7,138
Venezuela	1,994	76,189	95,503	1,781	72,193	87,420
Other	176 r/	6,588 r/	9,135 r/	158	7,408	9,003
Total 4/	17,596	752,067	917,329	24,085	962,667	1,192,061

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/ 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: Bureau of the Census.

TABLE 19
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	1997			1998		
		Value			Value	
	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
Anchorage:						
Canada	7	265	286	7	305	305
China	64	2,555	3,602	74	2,836	3,485
Japan	(3/)	5	5	--	--	--
Total 4/	71	2,825	3,892	83	3,141	3,790
Baltimore:						
Bahamas, The	--	--	--	26	967	967
China	(3/)	2	4	--	--	--
Germany	--	--	--	3	16	16
Netherlands	--	--	--	(3/)	126	132
Thailand	--	--	--	13	568	769
Turkey	--	--	--	27	1,018	1,018
Venezuela	169	7,001	7,001	190	8,190	8,193
Total 4/	169	7,004	7,005	258	10,884	11,094
Boston:						
Canada	9	258	262	24	677	687
Netherlands	(3/)	13	14	(3/)	135	150
Turkey	11	386	574	--	--	--
Total 4/	20	656	850	25	812	837
Buffalo:						
Canada	836	47,226	50,125	774	34,018	36,382
Netherlands	(3/)	28	28	--	--	--
United Kingdom	--	--	--	(3/)	10	10
Total 4/	836	47,254	50,154	774	34,028	36,393
Charleston:						
Canada	19	653	942	--	--	--
China	--	--	--	12	474	633
France	(3/)	3	5	27	896	1,159
Italy	--	--	--	54	305	793
Netherlands	(3/)	33	36	--	--	--
Saudi Arabia	--	--	--	20	298	595
Spain	--	--	--	253	9,911	13,363
Sweden	12	664	785	64	3,087	3,904
Thailand	--	--	--	62	1,026	1,690
Turkey	15	541	815	--	--	--
United Kingdom	(3/)	59	83	31	1,145	1,430
Venezuela	80	3,244	4,399	77	3,025	3,815
Total 4/	125	5,197	7,065	601	20,166	27,383
Chicago:						
Croatia	--	--	--	(3/)	4	4
Japan	(3/)	20	22	(3/)	17	19
United Kingdom	(3/)	3	4	(3/)	6	9
Total 4/	(3/)	23	26	1	26	32
Cleveland:						
Canada	628	35,817	36,622	966	43,807	45,364
Italy	--	--	--	(3/)	45	54
Netherlands	(3/)	94	111	--	--	--
United Kingdom	(3/)	93	122	(3/)	196	235
Total 4/	628	36,003	36,854	967	44,048	45,653
Columbia Snake:						
China	367	14,735	19,014	427	17,175	22,496
Colombia	54	2,189	2,997	--	--	--
Taiwan	10	435	546	--	--	--
Total 4/	432	17,360	22,556	427	17,175	22,496
Detroit:						
Belgium	--	--	--	129	6,477	6,527
Canada	1,664	86,466	95,989	2,130	79,382	94,347
France	--	--	--	11	920	930
Germany	(3/)	2	2	--	--	--
Greece	--	--	--	54	2,297	2,327
Netherlands	(3/)	86	101	(3/)	92	97
Thailand	--	--	--	27	1,467	1,477

See footnotes at end of table.

TABLE 19--Continued
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

	1997			1998		
		Value			Value	
Customs district and country	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
Detroit--Continued:						
United Kingdom	25	761	771	--	--	--
Total 4/	1,689	87,315	96,863	2,351	90,634	105,705
Duluth: Canada	345	13,468	15,485	327	14,312	16,564
El Paso:						
China	(3/)	2	2	--	--	--
Mexico	455	15,214	19,978	583	19,776	26,107
Total 4/	455	15,215	19,979	583	19,776	26,107
Great Falls:						
Canada	222	9,404	10,730	200	9,575	11,393
Japan	(3/)	2	3	--	--	--
Total 4/	223	9,406	10,734	200	9,575	11,393
Honolulu:						
Australia	83	2,692	4,013	103	2,617	4,256
China	--	--	--	113	3,164	3,842
United Kingdom	--	--	--	(3/)	12	15
Venezuela	180	5,433	9,063	--	--	--
Total 4/	263	8,125	13,076	217	5,794	8,114
Houston-Galveston:						
Canada	--	--	--	(3/)	5	7
Colombia	51	1,891	2,942	58	2,304	3,499
Denmark	192	6,818	9,134	204	7,779	10,019
France	3	373	487	(3/)	130	144
Germany	--	--	--	(3/)	8	10
Greece	217	7,874	10,206	411	15,068	20,278
Italy	--	--	--	15	589	757
Japan	(3/)	74	87	(3/)	54	66
Korea, Republic of	--	--	--	84	1,937	3,490
Saudi Arabia	--	--	--	68	2,701	3,343
Spain	520	20,429	25,445	487	19,925	27,903
Switzerland	--	--	--	34	1,333	1,638
Thailand	--	--	--	114	1,794	3,229
Turkey	32	1,696	2,176	250	9,079	12,811
United Kingdom	(3/)	20	26	(3/)	8	10
Venezuela	--	--	--	57	2,404	2,922
Total 4/	1,015	39,174	50,504	1,786	65,120	90,126
Laredo: Mexico	70	7,060	7,630	92	9,703	10,509
Los Angeles:						
Australia	--	--	--	(3/)	4	4
China	170	7,036	8,818	1,499	56,559	70,279
Colombia	32	1,284	1,757	--	--	--
France	62	3,261	3,329	--	--	--
Japan	--	--	--	15	561	702
Mexico	19	693	846	--	--	--
Spain	693	26,177	38,761	203	7,627	11,271
Thailand	--	--	--	41	1,892	2,042
Turkey	32	1,704	1,722	--	--	--
United Kingdom	(3/)	14	24	3	394	590
Total 4/	1,007	40,169	55,257	1,759	67,036	84,887
Miami:						
Belgium	2	388	422	(3/)	403	427
Colombia	--	--	--	(3/)	43	56
Denmark	8	476	857	26	908	1,199
Greece	14	488	631	--	--	--
Italy	(3/)	2	3	--	--	--
Mexico	--	--	--	11	849	1,104
Saudi Arabia	--	--	--	63	1,657	2,665
Spain	513	24,058	30,236	689	31,590	39,909
Sweden	497	15,349	20,183	626	18,458	24,581
Turkey	16	515	694	--	--	--
United Kingdom	--	--	--	(3/)	83	104
Venezuela	204	7,874	10,517	153	5,950	7,662
Total 4/	1,254	49,150	63,543	1,569	59,941	77,708

See footnotes at end of table.

TABLE 19--Continued
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

	1997			1998		
		Value			Value	
Customs district and country	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
Milwaukee: Canada	171	7,863	9,763	83	3,832	4,735
Minneapolis: Germany	(3/)	9	10	--	--	--
Mobile:						
Belgium	52	1,764	2,230	--	--	--
Bulgaria	55	1,548	2,234	26	715	1,032
China	--	--	--	34	1,180	1,596
Colombia	--	--	--	31	743	832
France	51	1,623	2,080	--	--	--
Korea, Republic of	--	--	--	103	2,566	3,791
Thailand	--	--	--	100	1,855	2,319
United Kingdom	--	--	--	(3/)	7	7
Venezuela	115	4,181	5,123	27	950	1,230
Total 4/	273	9,115	11,667	322	8,015	10,806
New Orleans:						
Belgium	--	--	--	148	4,971	6,952
China	4	389	466	885	32,800	43,076
Croatia	5	585	801	5	1,122	1,318
France	80	4,269	5,326	77	4,054	4,883
Greece	578	21,013	27,975	751	30,630	39,270
Italy	374	15,966	20,519	548	21,367	28,093
Korea, Republic of	--	--	--	35	486	1,049
Norway	--	--	--	34	1,227	1,674
Spain	18	717	885	133	5,369	6,864
Sweden	369	12,269	17,063	247	8,844	12,054
Thailand	--	--	--	158	3,690	4,762
Turkey	303	11,275	14,865	241	10,027	12,666
Venezuela	34	1,286	1,582	186	7,364	8,917
Total 4/	1,764	67,769	89,483	3,450	131,950	171,576
New York City:						
Belgium	(3/)	21	22	--	--	--
Denmark	55	2,814	3,097	65	3,557	4,256
Germany	--	--	--	(3/)	174	175
Greece	357	13,331	15,777	419	16,447	19,409
Italy	27	1,073	1,354	77	3,015	3,824
Netherlands	(3/)	195	207	(3/)	159	169
Norway	283	10,182	12,906	288	10,639	13,578
Tunisia	(3/)	12	18	--	--	--
Turkey	258	8,932	10,498	277	10,230	11,892
United Kingdom	(3/)	12	16	(3/)	57	66
Venezuela	21	738	902	--	--	--
Total 4/	1,001	37,309	44,797	1,127	44,278	53,369
Nogales: Mexico	439	13,342	17,446	566	17,105	22,366
Norfolk:						
Croatia	(3/)	2	4	--	--	--
Cyprus	--	--	--	134	5,382	7,027
Denmark	223	8,162	10,871	168	6,396	8,449
France	59	11,598	12,610	61	11,998	13,076
Greece	513	19,795	25,641	354	14,395	18,514
South Africa	(3/)	9	11	--	--	--
Tunisia	--	--	--	11	468	603
United Kingdom	2	564	760	1	247	272
Venezuela	20	834	1,110	90	3,031	4,097
Total 4/	817	40,964	51,008	819	41,918	52,039
Ogdensburg:						
Canada	334	12,814	14,361	208	7,374	7,984
Germany	--	--	--	(3/)	3	4
Total 4/	334	12,814	14,361	209	7,376	7,987
Pembina: Canada	186	8,650	9,910	232	10,684	13,228
Philadelphia:						
Colombia	--	--	--	27	972	1,220
Germany	--	--	--	(3/)	8	9
Korea, Republic of	--	--	--	39	587	1,401

See footnotes at end of table.

TABLE 19--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	1997 Quantity	1997 Value Customs 1/	1997 Value C.i.f. 2/	1998 Quantity	1998 Value Customs 1/	1998 Value C.i.f. 2/
Philadelphia--Continued:						
Thailand	--	--	--	164	2,863	4,017
Total 4/	--	--	--	230	4,430	6,647
Portland:						
Canada	15	828	910	30	2,477	2,583
Switzerland	--	--	--	31	965	1,246
Total 4/	15	828	910	62	3,443	3,829
Providence:						
Canada	26	733	770	24	629	653
Colombia	--	--	--	30	1,527	1,652
Greece	--	--	--	21	941	1,026
Spain	82	3,072	4,669	216	11,146	13,124
Total 4/	108	3,806	5,440	290	14,244	16,455
San Diego:						
China	--	--	--	160	5,989	7,229
Mexico	9	1,200	1,366	28	1,038	1,332
Total 4/	9	1,200	1,366	188	7,026	8,561
San Francisco:						
China	--	--	--	215	9,909	11,813
France	(3/)	15	21	--	--	--
Japan	--	--	--	(3/)	3	3
Thailand	--	--	--	40	1,865	2,780
Turkey	--	--	--	24	852	1,692
United Kingdom	(3/)	19	23	--	--	--
Venezuela	29	874	880	--	--	--
Total 4/	29	908	924	279	12,629	16,288
San Juan:						
Belgium	7	609	1,049	7	586	1,014
Canada	(3/)	2	3	--	--	--
Colombia	--	--	--	30	975	1,024
Cyprus	--	--	--	26	814	817
Denmark	20	1,557	2,783	14	1,182	2,136
France	--	--	--	27	819	1,075
Italy	--	--	--	41	1,460	1,731
Japan	--	--	--	(3/)	71	107
Luxembourg	1	63	110	--	--	--
Mexico	3	294	345	1	47	77
Spain	6	385	408	67	2,435	2,734
Turkey	8	376	572	10	373	580
Venezuela	161	5,854	6,744	80	2,607	3,159
Total 4/	206	9,140	12,014	303	11,369	14,455
Savannah:						
Australia	--	--	--	52	1,365	2,403
Bulgaria	91	2,538	3,753	--	--	--
Colombia	56	3,034	3,489	93	5,145	5,919
Denmark	(3/)	10	10	18	1,326	1,920
France	187	6,014	7,615	158	5,332	7,174
Saudi Arabia	--	--	--	34	1,159	1,548
Thailand	--	--	--	39	969	1,853
United Kingdom	126	5,730	6,853	83	3,628	4,365
Venezuela	114	4,025	5,004	48	2,090	2,523
Total 4/	574	21,351	26,724	526	21,014	27,705
Seattle:						
Canada	796	39,810	42,125	779	38,362	40,187
China	5	232	292	56	2,256	2,851
Colombia	191	7,770	11,046	234	9,749	13,727
Japan	(3/)	128	156	6	372	493
Taiwan	12	522	642	--	--	--
Total 4/	1,005	48,462	54,261	1,076	50,739	57,257
St. Albans:						
Canada	90	5,215	5,583	171	10,453	11,728
Netherlands	(3/)	136	152	--	--	--
Total 4/	90	5,351	5,735	171	10,453	11,728

See footnotes at end of table.

TABLE 19--Continued
U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER,
BY CUSTOMS DISTRICT AND COUNTRY

(Thousand metric tons and thousand dollars)

	1997			1998		
		Value			Value	
Customs district and country	Quantity	Customs 1/	C.i.f. 2/	Quantity	Customs 1/	C.i.f. 2/
Tampa:						
China	--	--	--	15	585	724
Colombia	522	20,731	24,946	660	28,486	33,945
Denmark	80	4,739	8,240	83	4,977	8,558
Greece	181	6,240	8,389	112	3,979	5,359
Spain	12	443	584	156	6,575	8,569
Sweden	9	338	406	--	--	--
Turkey	298	10,381	14,196	241	8,745	12,116
Venezuela	741	29,908	36,897	720	30,215	36,558
Total 4/	1,844	72,780	93,659	1,989	83,563	105,829
U.S. Virgin Islands:						
Antigua and Barbuda	(3/)	20	41	--	--	--
British Virgin Islands	2	5	10	--	--	--
Costa Rica	(3/)	2	2	--	--	--
Trinidad and Tobago	--	--	--	(3/)	1	2
Venezuela	65	2,543	3,026	51	2,121	2,545
Total 4/	67	2,571	3,080	51	2,122	2,548
Wilmington:						
Netherlands	(3/)	24	26	(3/)	38	40
United Kingdom	(3/)	16	20	(3/)	22	25
Venezuela	59	2,393	3,253	101	4,245	5,798
Total 4/	59	2,433	3,300	101	4,304	5,863
Grand total 4/	17,596	752,067	917,329	24,085	962,667	1,192,061

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/ 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/ Less than 1/2 unit.
4/ Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

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

(Thousand metric tons and thousand dollars)

	1997			1998		
		Value			Value	
Country	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Canada	4,086	202,335	218,025	3,745	166,444	179,797
China	606	24,560	31,726	3,307	127,254	160,882
Colombia	734	30,580	39,409	942	41,705	51,823
Cyprus	--	--	--	134	5,382	7,027
Denmark	467	17,175	22,614	459	17,852	23,182
France	133	6,075	6,978	124	4,926	6,134
Greece	1,672	61,789	79,495	1,957	77,481	98,496
Italy	344	14,802	19,060	709	25,746	33,886
Korea, Republic of	--	--	--	43	1,302	2,040
Mexico	885	25,945	34,707	1,131	32,586	43,948
Norway	276	9,407	12,051	314	11,048	14,352
Saudi Arabia	--	--	--	150	4,656	6,603
Spain	1,782	67,773	92,586	2,034	83,568	111,178
Sweden	887	28,620	38,437	937	30,383	40,532
Thailand	--	--	--	253	7,061	9,198
Turkey	827	31,037	39,751	1,071	40,324	52,774
United Kingdom	63	2,891	3,893	111	4,414	5,260
Venezuela	1,214	49,452	60,631	1,326	55,033	66,376
Other	23	998	1,240	243	9,109	11,377
Total 4/	13,999	573,439	700,603	18,990	745,897	924,865

1/ Includes imports into Puerto Rico.
2/ Custms 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/ 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: Bureau of the Census.

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

(Thousand metric tons and thousand dollars)

	1997			1998		
		Value			Value	
Country	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Belgium	9	998	1,473	8	989	1,441
Canada	215	16,858	18,024	285	22,530	24,176
Denmark	113	7,391	12,368	120	8,264	13,344
Luxembourg	1	63	110	--	--	--
Mexico	108	11,718	12,754	135	14,699	16,177
Norway	8	776	854	8	819	900
Spain	63	7,509	8,402	87	8,199	9,252
United Kingdom	4	197	284	5	271	475
Venezuela	--	--	--	1	131	139
Other	(4/)	197	212	(4/)	341	374
Total 5/	520	45,707	54,480	649	56,243	66,278

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/ 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: Bureau of the Census.

TABLE 22
U.S. IMPORTS FOR CONSUMPTION OF CLINKER, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1997			1998		
		Value			Value	
	Quantity	Customs 2/	C.i.f. 3/	Quantity	Customs 2/	C.i.f. 3/
Australia	83	2,692	4,013	155	3,982	6,659
Belgium	52	1,764	2,230	129	6,477	6,527
Canada	1,019	45,601	52,877	1,657	49,841	63,491
China	4	392	470	182	5,672	7,142
Colombia	173	6,318	7,768	223	8,197	9,994
France	304	18,721	21,932	233	16,979	19,837
Greece	181	6,240	8,389	167	6,276	7,687
Korea, Republic of	--	--	--	218	4,274	7,691
Thailand	--	--	--	504	10,928	15,740
Venezuela	780	26,730	34,863	453	16,908	20,739
Other	431 r/	14,878 r/	19,190 r/	213	6,819	8,416
Total 4/	3,027	123,336	151,732	4,134	136,353	173,923

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/ 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: Bureau of the Census.

TABLE 23
HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

Country	1994	1995	1996	1997	1998 e/
Afghanistan e/	115	115	116	116	116
Albania e/	100 r/	200	200	150	150
Algeria	6,060	6,822	6,900	7,100 r/ e/	7,800
Angola e/	240 r/	200 r/	270	301 2/	350
Argentina	6,276	5,447	5,117	6,858 r/	7,100
Armenia	100	228	282	297	310
Australia e/	6,500	6,500	6,500	6,500	6,500
Austria	4,828	3,843	3,874	3,852	3,850
Azerbaijan	467 r/	196 r/	223 r/	315 r/	201 2/
Bahrain	225 e/	197	193	172	230 2/
Bangladesh e/ 3/	280	280	650 r/	875 r/	900
Barbados	78	75	107	173	259 2/
Belarus	1,488	1,235	1,467	1,876	2,035 2/
Belgium	8,412 r/	8,223 r/	7,857 r/	8,052 r/	8,000
Benin	465	579	360 r/ e/	450 r/ e/	520
Bhutan e/	120	140	160	160	150
Bolivia	768	892	934	1,035 r/	1,050
Bosnia and Herzegovina e/	244 r/ 2/	226 r/ 2/	150	200	300
Brazil	25,230	28,256	34,597	38,069 r/	43,000
Brunei	--	--	100 e/	400 r/ e/	400
Bulgaria	1,910 r/	2,070	2,137	1,656 r/	1,700
Burkina Faso e/	--	30	30	40	40
Burma	470	517	505	516	365 2/
Cambodia e/	100	100	200	200	300
Cameroon e/	479 r/	552 r/	600	620 r/	450
Canada	10,584	10,440	11,587	12,015	12,064 p/
Chile	2,995	3,275	3,634	3,735 r/	3,750
China	421,180	475,910	491,190	511,730 r/	513,500 p/
Colombia	9,322	9,407 r/	8,907 r/	8,446 r/	9,190 2/
Congo (Brazzaville)	87 r/	96 r/	50 r/ e/	-- r/	-- 2/
Congo (Kinshasa) 4/	166 r/	235 r/	157 r/	140 r/	120
Costa Rica	940	865	830	940 r/	1,180 2/
Côte d'Ivoire e/	1,100 r/	1,000 r/	1,000 r/	1,100 r/	650
Croatia	2,055	1,708	1,842	2,134	2,000
Cuba	1,081	1,470	1,453	1,713	1,800
Cyprus	1,053	1,021	1,022 r/	910 r/	1,200 2/
Czech Republic	5,303	4,825	5,015 r/	4,877 r/	5,000
Denmark 5/	2,430	2,584	2,629	2,683	2,528 2/
Dominican Republic	1,276 r/	1,453 r/	1,642 r/	1,835 r/	1,885 2/
Ecuador	2,164	2,616	2,677	2,688	2,690
Egypt	16,100 r/	17,665	18,700 r/	18,100 r/	19,203 2/
El Salvador	850	890	948	1,020 r/	1,077 2/
Eritrea	45 e/	50	47	60 r/ e/	50
Estonia	402	417	388	423 r/	321 2/
Ethiopia	464	611	663 r/	750 r/ e/	775
Fiji	94	91	84	84 e/	80
Finland	869 r/	907	975	905 r/	903 2/
France	21,296	19,692	19,514 r/	19,780 r/	19,500
French Guiana	38	60	52	51	50
Gabon	126	154	185 r/	200 e/	196 2/
Georgia	100	100 e/	85	91	85
Germany	36,130 r/	33,302 r/	31,533 r/	35,945 r/	36,610
Ghana e/	1,346 2/	1,300	1,500 r/	1,700 r/	2,000
Greece e/	12,636 2/	14,480 r/	14,700 r/	14,982 r/	15,000
Guadeloupe e/	230	230	230	230	230
Guatemala	1,200	1,152	1,090	1,280	1,500 p/
Guinea e/	250	250	260	260	260
Haiti	-- r/	--	--	--	--
Honduras	615 r/	721	952	980 e/	1,250 p/
Hong Kong	1,927	1,913	2,027	1,925	1,539
Hungary	2,813	2,875	2,747 r/	2,811 r/	2,999 2/
Iceland	81	82	88	101 r/	100
India e/	57,000	62,000	75,000	80,000	85,000
Indonesia	21,907	23,129	25,000 e/	27,500 r/ e/	22,000

See footnotes at end of table.

TABLE 23--Continued
HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

Country	1994	1995	1996	1997	1998 e/
Iran e/	16,000	16,300	16,500 r/	15,200 r/	17,000
Iraq e/	2,000	2,108 2/	2,100	1,598 r/	1,700
Ireland	1,623	1,730	1,933 r/	2,100 r/	2,000
Israel	4,800	6,204	6,700 e/	5,400 r/	5,400
Italy	32,713	33,715	33,327	33,721	35,000
Jamaica	445	522	557 r/	591 r/	558 2/
Japan	91,624	90,474	94,492	91,938	81,328 2/
Jordan	4,000 e/	3,508	3,415	3,251	1,386 2/
Kazakhstan	2,000	2,616	1,120	661 e/	600
Kenya	1,452 r/	1,566 r/	1,816 r/	1,506 r/	1,200
Korea, North e/	17,000	17,000	17,000	17,000	17,000
Korea, Republic of	50,730	55,130	58,434 r/	60,317 r/	46,791
Kuwait e/	1,000	1,950 2/	2,000	2,000	2,000
Kyrgyzstan	400 r/	310 r/	544 r/	658	710
Laos e/	10	10	9	8 r/	9
Latvia	244	203	325	246	366 2/
Lebanon e/	3,450	3,538 2/	3,700	2,703 r/	4,000
Liberia e/	3 r/	5 r/	15 r/	7 r/	10
Libya	3,800 r/	3,210	3,550	2,524 r/	3,000
Lithuania	736	649	600 e/	714 r/	788 2/
Luxembourg	711	714	667	650 r/ e/	650
Macedonia	486	524	491	500 e/	500
Madagascar e/	40 r/	40 r/	80 r/	120 r/	120
Malawi	122	139	91 r/	176 r/	175
Malaysia	9,928	10,713	12,349	12,668 r/	10,397 2/
Mali e/	15	13	12 r/	10 r/	10
Martinique e/	220	220	220	220	220
Mauritania e/	374	120	100 r/	80 r/	50
Mexico	29,700	24,043 r/	25,366	27,548	27,744 2/
Moldova	39	49	40	122	74 2/
Mongolia	86	109	106	112	109 2/
Morocco	6,350	6,401	6,585 r/	7,184 r/	7,200
Mozambique e/	60	60	180 r/	220 r/	290
Namibia e/	20	20	20	20	20
Nepal 3/	316	327	309	225 r/	280
Netherlands	3,180	3,180 r/	3,140 r/	3,230 r/	3,200
New Caledonia e/	90	100	100	100	100
New Zealand	900 e/	950 e/	974	976	975
Nicaragua	309	324	360 r/	310 r/	336 2/
Niger e/	29 r/	30	29 r/ 2/	36 r/	35
Nigeria	2,627 r/	2,602 r/	2,545 r/	2,520 r/	2,700
Norway	1,444	1,613	1,664	1,724 r/	1,676 2/
Oman	1,200 e/	1,177	1,260	1,264 r/	1,300
Pakistan	8,100	8,586	8,900 e/	9,001 r/	8,901 2/
Panama	615	615	647	700 r/	750 2/
Paraguay	659 r/	635	613 r/	620	556 2/
Peru	3,177 r/	3,792 r/	3,848	4,300 r/	4,340 2/
Philippines	9,571 r/	10,554 r/	12,429 r/	14,681 r/	13,338 2/
Poland	13,834	13,914 r/	13,959 r/	15,003 r/	14,970 2/
Portugal	7,977	8,123	8,455 r/	9,395 r/	9,500
Qatar	469	475	690	692 r/	700
Réunion	321	313	299	277	300
Romania	6,676 r/	6,842	6,956	7,298	7,000
Russia	37,200	36,500	27,800	26,700 r/	26,000
Rwanda e/	10	10 r/	15 r/	15 r/	15
Saudi Arabia	15,000 e/	15,773	16,437	15,400	14,500
Senegal e/	685 r/	694 r/	811 r/	854 r/	1,000
Serbia and Montenegro	1,612	1,696	2,205 r/	2,011 r/	2,300
Sierra Leone e/	100	100	160	50	100
Singapore e/	3,100	3,200	3,300	3,300	3,300
Slovakia e/	2,700 r/	2,902 r/	2,802 r/	3,017 r/	3,000
Slovenia	898	991	1,026 r/	1,113 r/	1,100
Somalia e/	25	25	-- r/	-- r/	--
South Africa	7,905	9,071	9,000 e/	9,500 r/ e/	9,500

See footnotes at end of table.

TABLE 23--Continued
HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

Country	1994	1995	1996	1997	1998 e/
Spain (including Canary Islands)	25,150	26,423	25,157	27,632	27,943 2/
Sri Lanka e/	925 2/	894 r/	928 r/	965 r/	1,100
Sudan e/	160 r/	391 2/	380	291 r/	300
Suriname e/	60 r/	60 r/	60 r/	65 r/	65
Sweden	2,153	2,539 r/	2,447	2,253 r/	2,105 2/
Switzerland e/	4,370 r/	4,024 r/	3,638 r/	3,568 r/	3,600
Syria e/	4,500	4,463 2/	4,500	4,460 r/ 2/	4,500
Taiwan	22,722	22,478	21,537	21,522	19,538 2/
Tajikistan	200	100	50	36 r/	18 2/
Tanzania	315 r/	320 r/	300 r/	275 r/	300
Thailand e/	29,900	34,900	38,600 r/	37,309 r/	30,000
Togo e/	286 r/	440 r/	413 r/	421 r/	565
Trinidad and Tobago	583	559	617	653	690 2/
Tunisia	4,606	4,938	4,567	4,431	4,590 2/
Turkmenistan	700	437	451	450 e/	450
Turkey	29,493	33,153	35,214	36,035	38,200 2/
Uganda	36 r/ e/	85 e/	180 r/	203 r/	210
Ukraine	11,400	7,600	5,017 r/	5,098 r/	5,589 2/
United Arab Emirates e/	5,000	5,918 2/	6,000	5,250 r/	6,000
United Kingdom	12,307	11,805	12,214	12,638 r/	12,409 2/
United States (including Puerto Rico) 6/	79,353	78,320	80,818	84,255	85,522 2/
Uruguay	707 r/	585 r/	685	781 r/	960 2/
Uzbekistan	4,800	3,400	3,300 r/	3,300 r/	3,400
Venezuela	6,927	7,672	7,556	7,600 e/	7,867
Vietnam e/	4,700	5,200	6,600 r/	7,500 r/	6,000
Yemen	800 e/	1,088	1,040	1,229 r/	1,200
Zambia	280	312 r/	348 r/	384 r/	400
Zimbabwe	1,070	968 r/	1,000 r/ e/	1,100 r/ e/	1,100
Total 7/	1,370,000 r/	1,444,000 r/	1,493,000 r/	1,540,000 r/	1,519,000

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

1/ Table includes data available through September 22, 1999. 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/ Sales data for years 1994 and 1995 only.

6/ Portland and masonary cement only.

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