CEMENT AND LIME MANUFACTURE

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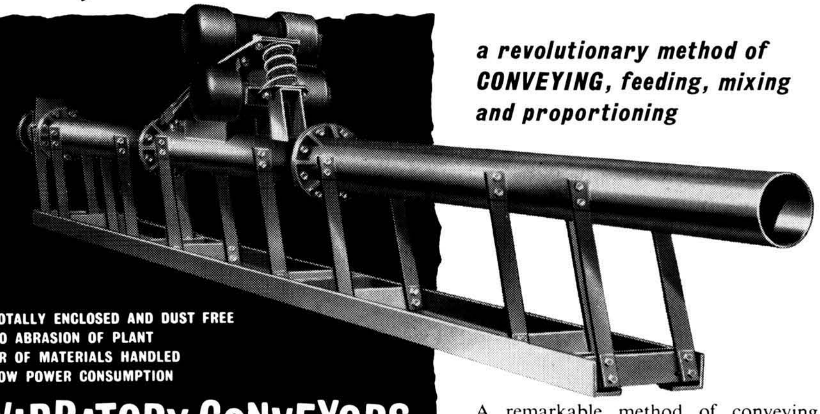

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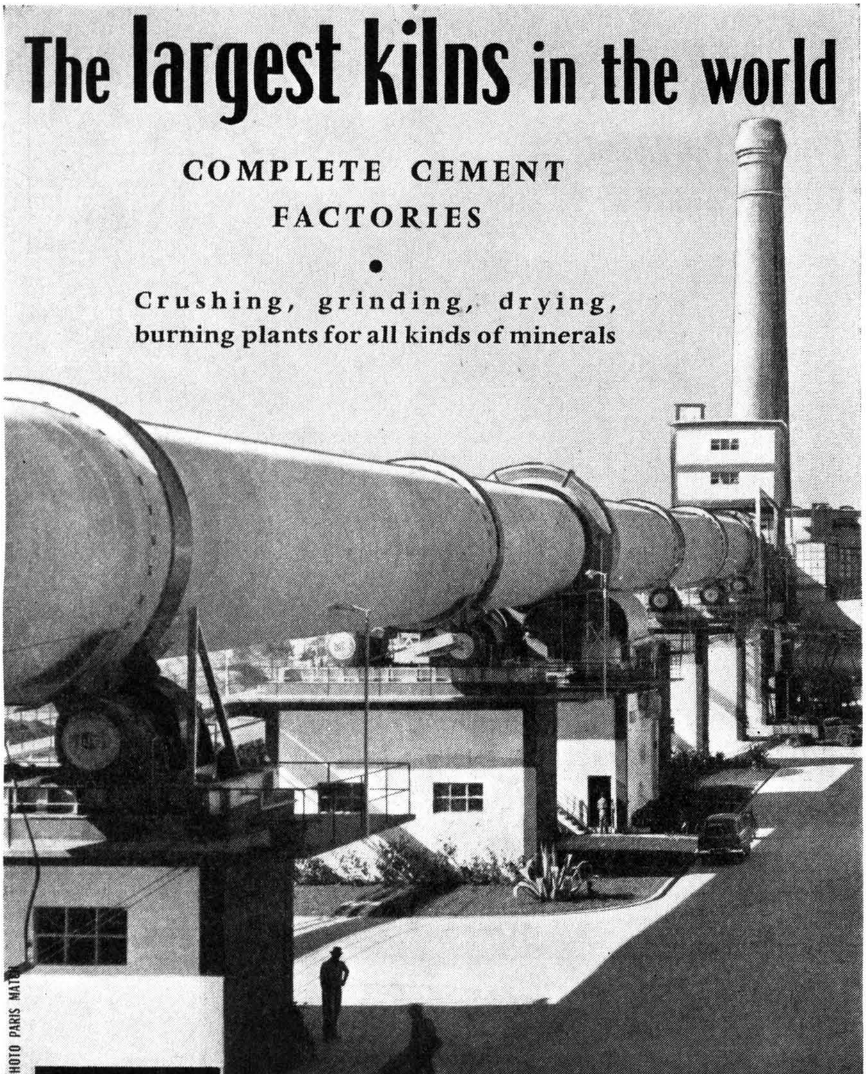

Alhandra cement factory (Portugal). View of the kiln (167.5 m x 4.8/5.3 m - 1600 T/day)

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A New Dry-process Works in U.S.A.

Production at the new dry-process cement works (*Fig.* 1) of the Oklahoma Cement Co., at Pryor, Oklahoma, U.S.A., commenced in July 1960. The works, which was erected in the short time of seventeen months, will have an annual capacity of about 200,000 tons, and at first the output is being used for dams in the course of construction at Keystone and Eufala.

Raw Materials.

The keynote of the works is the efficient operation and the simple flow of materials from the quarry through the works to the packing department. Belt-conveyors transport the crushed hard shale and limestone to the storage building. Supplies of the raw materials are sufficient for centuries of continuous operation. The site of the deposit of shale and the limestone quarry are less than 500 yd. from the crushers. A 2½-cu. yd. excavator loads two 20-ton end-dump lorries in which the materials are transported to a 50-in. by 50-in. primary hammer-mill. Normally, one day a week stripping shale and three or four days a week quarrying limestone are sufficient to keep the raw-mill supplied at present. The fines are extracted from the flow of quarry-run material, either shale or limestone, by a 48-in. by 18-bar wobbler-feeder, and drop on to the lower end of the belt-conveyor to form a cushion for the crushed material. A 42-in. apron-conveyor under the hammer-mill breaks the impact of material as it falls out of the bottom of the hammer-mill and deposits it gently on the bed of material already on the inclined belt-conveyor. The raw materials pass over a 5-ft. by 14-ft. vibrating screen from which material over ½ in. is returned to the hammer-mill. The screen is fitted with a top deck with openings 2 in. square to protect the fine screen of the lower deck from the impact of random oversized pieces of stone.

Another belt-conveyor, provided with a travelling tripper, distributes the screened materials along the side of the storage building. A 3½-cu. yd. overhead

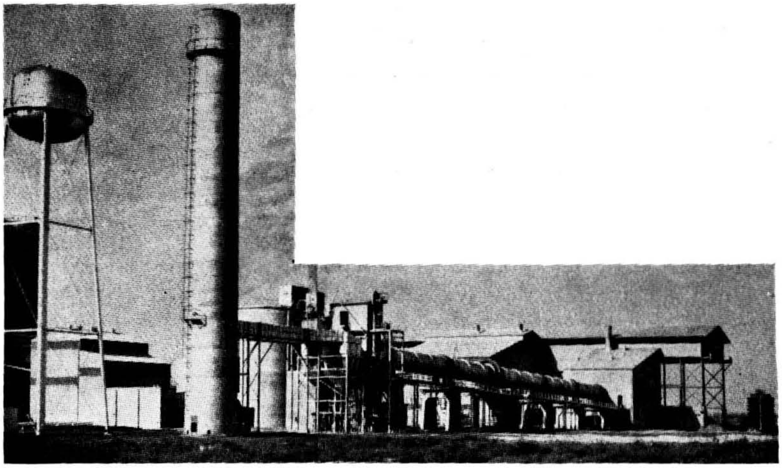


Fig. 1.

crane transfers the material to the mill feed-hoppers. A lorry dumper and bucket-elevator deposits gypsum, sand, iron ore and other materials over the concrete retaining wall of the storage building to within the reach of the overhead crane.

The shale is rock-hard and dense when dry, but may absorb moisture during wet weather that would retard its progress through the raw-mill. Therefore the overhead crane deposits moist shale in a 50-ton hopper fitted with an apron-feeder, from which it is passed through a 6-ft. by 50-ft. concurrent flow-dryer (*Fig.* 2); the dried material is returned to storage by a bucket-elevator.

Grinding.

Grinding is carried out in two practically identical circuits each comprising an 11-ft. by 20-ft. two-compartment mill which can grind the raw material or clinker. One of the mills normally grinds the kiln-feed materials and has extra feeders for the raw-material and a large furnace connected to an air-separator; this will be its exclusive duty until an air-conveyor system is installed by which cement can be transported to storage. This mill is equipped with five weighing feeders with variable-speed controls. The largest unit in this group has a capacity between 8 and 40 tons per hour and is used for feeding either limestone or clinker to the gathering belt that loads the mill. Another of the five feeders handles only iron ore, and another only shale. The smallest two feeders handle clay and gypsum at rates of between 1 and 5 tons per hour, the latter rate being for gypsum.

Both mills are partially air-swept to reduce the load in the 16-ft. air-separator in each mill circuit. A pre-cleaner cyclone (*Fig.* 3) in each air-circuit extracts air-borne oversized materials to protect the bag-collectors. The oversized pieces are returned to the mill circuit and the fines go into the pneumatic conveyor system leading to the storage silos.

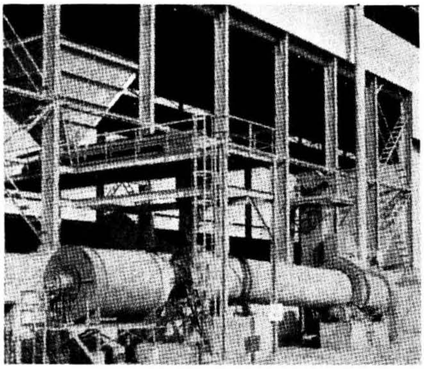


Fig. 2.—Shale Dryer

The primary mill circuits are designed for a recirculating load of about 600 per cent., that is about 270 tons of material per hour. The discharge from the mill drops on to an air-slide for the short journey to the boot of a bucket-elevator which lifts the materials to an air-separator installed in the top of the mill building. Oversized material from the separator is fed back to the mill by chutes, while accepted fines are dropped into the feed-hopper of the pneumatic handling system for transport to storage.

One of the mills deals with finish grinding only. Under the supply hoppers there are weighing feeders, with variable-speed drives, which discharge on to an inclined belt-conveyor that delivers the materials into the mill. The head-end

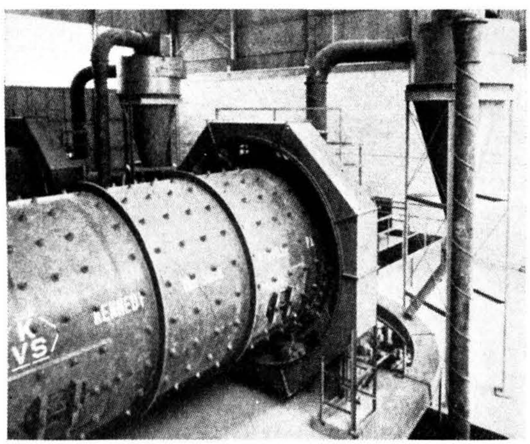


Fig. 3. Pre-cleaner Cyclones for extracting air-borne oversized pieces from raw material mills.

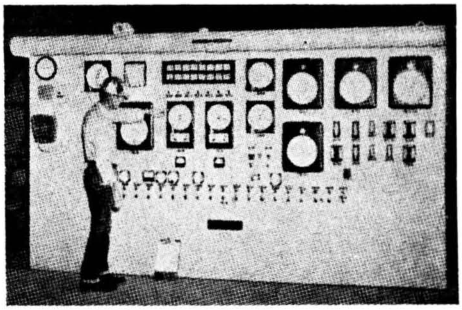


Fig. 4.

of the conveyor has a tank and ferris-wheel feeder to supply an admixture when air-entraining cement is being made.

The kiln-feed materials are pumped to one of three concrete storage and blending silos each of which has a capacity of about 1400 tons. With three units in the storage system it is possible to be filling one, blending in another, while the third is discharging into a 250-ton kiln-feed silo through a constant-level feed-box. The silo is also fitted with mixing valves for compressed air to agitate the materials while they are being fed to the kiln.

Burning.

The 11-ft. by 375-ft. gas-fired kiln is fed uniformly through a constant head-feeder and screw-conveyor system. This raw material is supplemented with dust that is returned to the system from the dust-collecting cyclones, from the kiln-hood housing, and from a dust chamber in front of the cyclones. A screw-conveyor system collects the dust and drops it into the boot of a bucket-elevator by which it is lifted to the top of the kiln-feed pipe. The kiln control panel is shown in *Fig.* 4.

Fuel for the kiln is cheap and plentiful. Natural-gas is brought to the works by pipeline from local transmission pipes. Oil from local supplies is stored as a standby fuel.

The material from the kiln drops on to a 6-ft. by 37-ft. horizontal grate-cooler. Clinker and clinker dust are collected by a drag-chain conveyor which discharges into the boot of a bucket-elevator by which it is lifted over the retaining wall of the storage building, where the clinker is distributed into storage by the overhead crane.

Packing.

Cement from the finishing mills is stored in a battery of six silos having a combined capacity of about 23,000 tons of cement. Each silo is equipped with quadrant aeration units, and each discharges to one of three parallel air-slide systems, which supply the railway-loading dock, the lorry-loading dock, and the packing house respectively.

The packing house is equipped with two four-spout bagging machines each of which fill twenty-four bags per minute. From the bagging machine, the bags of cement are transported on a flexible conveyor system to the loading docks, or to a palletting machine, or to a bag-storage building. Spillings and dust in the packing house are collected and returned to surge bins. An air-slide under each bagging machine collects spillings and discharges into the boot of a bucket-elevator by which it is fed into the overhead bins. Dust from each of the two bag collectors and the small cyclones in the packing house is also fed into the elevator to be returned to the system.

The works, which is arranged so that it can be extended conveniently, was designed and built by Messrs. George A. Fuller Co. The information in the foregoing is abstracted from " Rock Products," December, 1960.

The Dry-process in Russia.

THE Deputy Minister of the Building Materials Industry of the U.S.S.R. visited Great Britain last autumn and some of the views he expressed at an interview with representatives of the cement manufacturers of this country are given in the following.

The opinion was expressed that the dry process of manufacture is the most economical method in Russia but extensive discussions were proceeding on this matter. It is necessary to prepare the raw materials wet but to dry the feed before passing it into the kiln. A vacuum type of filter, as used in some works in the Argentine, should be used for drying the materials and such plant of American design has been installed in works in Estonia. There is about 15 per cent. of moisture in the feed to the kiln. The filter cloth used in the Russian plants is made of a natural fibrous material with the addition of 30 per cent. of nylon. The problem of filtering is complicated and not all the material is filtered sufficiently. The layer of slurry is about 1 in. thick. The raw materials include a hard limestone. Natural gas, oil and coal are used for firing the kilns. Clinker rings form with all types of fuel but less so if natural gas is used.

Booklet Received.

"Judgment in the Restrictive Practices Court on an Agreement Between Members of the Cement Makers' Federation." (Obtainable gratis from the Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.)

The Volumetric Stability of Building Lime.

A STUDY of delayed instability of building lime was reported by H. HARTMANN, G. WEISEL and W. WEGENER in a recent number of "Zement-Kalk-Gips."

A lime-mortar plaster containing aggregate known to be sound, produced numerous craters 0·1 to 2 cm. in diameter eight weeks after application. In the bottom of the craters were yellow to greenish-brown nuclei of various sizes between 1 and 4 mm. Material was collected from these coloured nuclei and the chemical composition determined. The proportions of soluble silica and iron oxide were notably high.

A synthetic raw material was then made up with a similar composition (excluding loss on ignition). The analysis was as follows: 71·24 per cent. of CaO; 10·72 per cent. of insoluble SiO_2; 10·47 per cent. of soluble SiO_2; 3·52 per cent. of Al_2O_3; 3·44 per cent. of Fe_2O_3; and 0·61 per cent. of MgO. A series of burnings was carried out at the temperatures of 1000, 1175 and 1400 deg. C. Portions of the raw material for a stable fat lime were burned at each of the temperatures and slaked by steam.

Proportions of 5 per cent. of each of the three products were then mixed with separate portions of a stable fat slaked lime, and tested for volumetric stability. Only the mixture containing the addition burnt at 1000 deg. C. was then stable.

Analysis of the stable lime and the equivalent overburnt lime showed that the overburnt lime contained an increased proportion of acidic constituents at the expense of the basic constituents.

Portions of the synthetic raw material were burned at each of the same three temperatures and slaked. Mixtures containing 5 per cent. of each of the unslaked and slaked products with separate portions of the stable lime were tested for volumetric stability. Only the mixture containing the addition burnt at 1000 deg. C. and slaked was stable.

Further tests for volumetric stability was made on the stable lime containing additions of 5 per cent. of certain combinations of oxides. Additions containing CaO-SiO_2-Al_2O_3 21:6:1 and 19:3:1 gave no instability even at 1400 deg. C. CaO-SiO_2-Fe_2O_3 in ratios 21:6·2:1 gave stability at 1000 deg. C., but not at the other temperatures. CaO-Fe_2O_3 in the ratio 21:1 gave stability at 1000 deg. C. but not at the other temperatures. The following mixtures gave stability at 1400 deg. C. CaO-Al_2O_3 in ratios 22:1 and 12:1; CaO-SiO_2 in ratios 3·4:1 and 6·8:1; and SiO_2-Fe_2O_3 in ratios 6:1 and 13:1. Chemically-pure lime burned at 1400 deg. C. was perfectly sound.

The more highly burned mixtures of lime and iron oxide showed considerable sintering which did not occur in the mixtures free from iron. The sintering arrested the normal slaking process, so that delayed hydration caused unsoundness. The presence of silicic acid tended to annul the delayed hydration caused by iron oxide.

As the specific gravity of the sintered portions containing calcium ferrite is liable to be over 3·0, a suitable liquid for its separation by sedimentation is α, α, β, β, tetrabromoethane ($D_{20} = 2{\cdot}97$).

The Penetration of Water into a Grain of Clinker.

A METHOD of estimating the depth of penetration of water into a particle of clinker has been developed by Mr. A. R. STEINHERZ who gives, in "Revue des Materiaux de Construction," May 1960, a description of the results of applying this method to clinkers of different composition.

The method is based on the supposition that water attacks the grains of clinker at an equal rate all over the surface so that a covering of hydrated cement of uniform depth then covers the unaffected nucleus. The thickness of the envelope of gel is calculated in terms of the volume of the cement which has been hydrated, by means of a statistical analysis of the sizes and shapes of the particles. The extent of hydration is measured by means of the changes in heat of hydration. Specific surface was measured by air-permeability or by examination under the microscope.

Two types of clinker were used corresponding to ordinary Portland cement and Portland cement with a low potential value of tricalcium aluminate. Particles of clinker, of sizes between 20 and 40 microns, ground by different mills, were separated by fractional sedimentation in absolute ethyl alcohol containing a small amount of calcium chloride. The potential composition was determined for each case. The process of separation caused some variation in the potential composition but only within the limits of the type of cement concerned.

For the measurement of heat of hydration, an addition of 5 per cent. of chemically-pure calcium sulphate dihydrate in very finely powdered form was made to portions of each of the separated fractions of clinker. The mixture of nitric and hydrofluoric acids did not completely wet particles of unhydrated clinker but hydrated particles were readily dissolved. It was concluded that the thin skin of products of hydration said to cover fresh cement grains must have been removed by frequent washing with ethyl alcohol. The difficulty was overcome by the addition of a few drops of a non-ionic surface-active agent.

The mixture of clinker with calcium sulphate dihydrate did not dissolve completely even in the presence of surface-active agent, so that the heat of hydration of the unhydrated clinker instead of the unhydrated cement had to be determined.

All the cements were gauged with 40 per cent. of distilled water, and after thorough mixing the paste was stirred at constant temperature in a hermetically sealed vessel containing air saturated with water but free from carbon dioxide. The values of the heat of hydration had to be related to calcined material, which with the cements was 96 per cent. of clinker and 4 per cent. of anhydrous calcium sulphate. Since calcium sulphate dissolves without appreciable heating effect, the measured heat of solution was divided by 0·96.

The heat of hydration of each of the partly hydrated cements was determined at one, three and twenty-eight days.

The calculated depths of penetration of water were only influenced by the shape of the particles, or the type of mill by which they were produced, during the first few days of the process of hydration.

Cements with a low potential value of tricalcium aluminate gave much less penetration at twenty-eight days than in the case of ordinary Portland cements.

From the depth of penetration on the larger particles, it is concluded that particles smaller than 2 microns are completely hydrated after two days.

Fractions of ordinary Portland cements between 1 micron and 5 microns were separated. These had normal compositions except that the percentage of calcium sulphate was increased by the process of separation. These fractions reached a constant heat of hydration after a day or two, but they did not quite attain complete hydration. When portions of these fine fractions were mixed with the coarser fractions of cement, the depth of penetration of water into the coarse grains appeared to increase. The presence of 2·5 per cent. of potassium sulphate in the gauging water also increased the depth of penetration.

Investigations of Lime-burning Processes.

IN "Proceedings No. 32" of the Swedish Cement and Concrete Research Institute (published in Stockholm, 1961; price 20 kr.), MR. RUNE HEDIN deals with the subject of "Investigations of the Lime Burning Processes."

Crystals of Icelandic spar, in the form of cleavage rhombohedrons with an edge length of about 2 mm., were dissociated in a furnace enclosed in an autoclave. The structure of the oxidized surface as viewed by an electron microscope was determined at various furnace temperatures from 690 deg. C. to 1220 deg. C., different furnace pressures from about 2 mm. Hg. to nearly equilibrium pressure, and for different periods of time. The effects of the results of post-heating to a higher temperature on the external volume and surface structure were also investigated. (The publication contains over three hundred reproductions of the micro-photographs.)

The conclusions from the results of the tests are as follows.

Below 1070 deg. C., the velocity of dissociation is determined by a coupling of heat radiation and chemical process, which contains a nucleation step.

The structure of the oxide depends on the temperature and on the velocity of decomposition, according to current nucleation theories. The sintering is believed to increase with temperature and velocity of decomposition.

Above 1070 deg. C., the sintering influences the reaction velocity with respect to the resistance to the flow of gas, and the velocity influences the sintering with respect to the nucleation process, giving rise to a complicated increase-decrease behaviour in the reaction velocity and the shrinkage.

Above 1180 deg. C., the effect of sintering on the velocity of decomposition becomes less important, probably due to the high internal pressure.

International Symposium on Chemistry of Cement.

THE Fourth International Symposium on the Chemistry of Cement was held in October last at Washington, D.C. The Symposium was organised jointly by the National Bureau of Standards (U.S.A.) and The Portland Cement Association (U.S.A.). In the following is given a summary of the proceedings which is based on a report prepared by the Bureau.

The principal subjects dealt with were the chemistry of clinker, the chemistry of hydration of cement compounds and of Portland cement, the properties of cement paste and concrete, destructive processes in concrete, and special cements. The guest speakers at the opening session were Dr. W. R. Brode and Dr. F. M. Lea.

In his address on " Some Problems associated with the Growth of Science," Dr. Wallace R. Brode, former associate director of the Bureau, stated that good co-ordination and communication are needed nationally and internationally to advance the distribution of science and technology. Reviewing the progress of cement research since the last Symposium, Dr. F. M. Lea, Director of the Building Research Station (Great Britain), in an address on " Cement Research, Retrospect and Prospect," pointed out that perhaps the most notable feature of the Fourth Symposium in comparison with the previous meeting in 1952, is the increased proportion of papers dealing with the hydration of cement. Recent research has led to a fair picture of the chemical and physical nature of set cement, but much remains to be learned about the kinetics of the initial reactions and the mechanism by which the initial framework of setting cement is developed.

Summaries of the principal reports and papers given in subsequent sessions are given in the following.

Cement Clinker.

The chemistry of Portland cement clinker, in its broader aspects, was fairly well understood even prior to the previous international symposium. Therefore, investigations since then have dealt mainly with such subjects as solid solutions, the effects of minor constituents, and new and improved experimental procedures. Considerable work has been done in the United Kingdom and elsewhere to determine the extent and nature of a solid solution of magnesium oxide and aluminium oxide in tricalcium silicate to form the clinker mineral known as alite. Universal agreement has not been reached on this subject. Development and use of improved techniques for estimating clinker constituents by X-ray diffraction analysis evoked considerable discussion at the meetings.

Hydration.

Although the chemistry of hydration of cement compounds has been a very active field of research, hydration is still not thoroughly understood. Through the work of Mr. S. Brunauer and co-workers at the Portland Cement Association, as well as of numerous other investigators, some of the products of hydration have been established. According to Dr. Brunauer, the two chief constituents of cement, tricalcium silicate and β-dicalcium silicate, combine with water at ordinary temperature to produce calcium hydroxide and a hydrated calcium silicate similar to natural tobermorite. However, under hydrothermal conditions, the same anhydrous compounds, or oxide mixtures of equivalent compositions, yield a large number of different calcium-silicate hydrates. The relationships of the several species and their conditions of stability were discussed by Mr. H. F.W. Taylor (University of Aberdeen). Hydrated aluminates, ferrites, and sulfo-aluminates have also been studied.

Among numerous techniques now being used for studying hydration are infra-red absorption and radio-active tracers. Having conducted experiments with radioactive calcium, Mr. T. Thorvaldson (University of Saskatchewan),pointed out that calcium exchange occurs between hydrated tricalcium silicate and calcium-hydroxide solution when these two substances are in equilibrium.

Detailed investigations are being carried out on the hydration of Portland cement, a very complex reaction involving numerous steps with different rates. From these studies, it has been established that hydrated Portland cement consists of crystalline materials. Here again, many new techniques and methods have been utilized. For differential thermal analysis, equipment for heating four samples simultaneously while automatically recording thermal effects was described by Mr. Kenneth Greene (Ideal Cement Co.). By applying this method to cements that have been in contact with water for increasing periods of time, information is obtained on the progressive formation of hydration products which are identifiable by their characteristic thermal effects. Development of a successful system of X-ray diffraction analysis of hydrated cement was described by Mr. D. L. Kantro and Mr. L. E. Copeland (Portland Cement Association). Nuclear magnetic resonance is being applied to a study of the nature of bonding of the water in hydrated calcium silicates and in cements.

False set, a troublesome phenomenon familiar to the cement industry but imperfectly understood, was reported on by Mr. W. C. Hansen (Universal Atlas Cement Co.). Although there is general agreement that false set may result from the presence of partially dehydrated gypsum in the cement, the effects of composition, temperature, and aeration are very complex, and the problem cannot yet be considered entirely solved.

Cement Paste.

Knowledge of the structure of hardened cement paste has been widely extended through the use of the electron microscope, as related by Mr. A. Grudemo (Cement and Concrete Institute of Sweden), Mr. W. Czernin (Austrian Cement Research Institute), and Mr. L. E. Copeland and Miss Edith Schulz (Portland Cement Association). The silicate formed by the hydration of the calcium silicates appears gelatinous under the ordinary microscope, but is shown by the electron microscope to consist of either acicular particles or exceedingly thin, flexible foils—depending on conditions of hydration. Mr. T. C. Powers (Portland Cement Association) pointed out that chemical composition has little effect on the physical properties of cement paste within the range of normal cements. The hardened paste is a colloidal material having a surface area of the order of 200 sq.m. per gramme, very much higher than that of the unhydrated cement. It is the structure, rather than its

composition, which largely determines such mechanical properties of the cement, and hence of the concrete, as strength, elasticity, volume changes, and creep.

One phase of research on destructive processes in concrete concerns chemical reactions involving aggregates. Mr. N. Plum (Danish National Institute of Building Research) particularly stressed the alkali-aggregate reaction which has resulted in much damage in the U.S.A. Investigations were made at the Bureau on the deterioration of hardened cement in aggressive solutions. From a series of mortar-bar tests of various types of cement exposed to different aggressive solutions supersulphate cements, which are widely used in Europe if high resistance to disintegration is desired, were found to perform no better, in many cases, than special cements common in this country. Mr. P. Nerenst (Danish Gas Concrete Inc.) suggested a mechanism for the effect of frost action in concrete.

Special Cements.

Dr. V. V. Mikhailov (Academy of Construction & Architecture, U.S.S.R.) stated that an expanding cement which may be self-stressing has been developed. The cement consists of an interground mixture of high-alumina and Portland cements and gypsum in a small amount of water. When this cement is immersed in water for short periods, expansion occurs. According to Dr. Mikhailov, this expansion can be controlled to give the desired degree of stressing.

Little is known about the influence of the different chemical components of pozzolanas. However, Mr. G. Malquori (University of Naples) reported that he had found that the silica and alumina consituents of pozzolanas react to form products nearly the same as those formed in the hydration of Portland cement. Reactions involving the iron and alkali components of pozzolanas have not, as yet, been determined. The most significant finding in high-alumina cements, as reviewed by Mr. P. L'Hopitallier and presented by Mr. R. Rabot (LaFarge Cement Co.), is that the chief hydration product is mono-calcium aluminate hydrate, rather than di- or tri-calcium as believed earlier.

Symposium on the Durability of Concrete.

An International Symposium on the Durability of Concrete is to be held in Prague this year. The Symposium is in connection with the fifteenth session of the Permanent Committee of Rilem (Réunion Internationale des Laboratoires d'Essais et de Récherches sur les Matériaux et les Constructions) which takes place from July 30 to August 6, 1961. The Symposium will deal with the following subjects. Theoretical matters relating to the durability of concrete; the mechanics of concrete-texture deterioration; durability tests and control; the composition of durable concrete; experiences of concrete structures.

The symposium is being organised by the Czechoslovakian Academy of Sciences. Particulars are obtainable from the Institute of Theoretical and Applied Mechanics, Solinova 7, Prague 6-Dejvice.

Accident Prevention in the Cement Industry.

THE Report for 1960 on Accident Prevention issued by the Blue Circle group of cement companies, states that the year, which was the fortieth year of active effort towards accident prevention, was one of outstanding progress in so far that a record low frequency rate of 0·50 was attained. At ten works there were no lost-time accidents and at each of five other works there was only one accident. About half the number of injuries caused by accidents were merely cuts and bruises, and about a quarter were fractures, strains, or sprains. There were three fatal accidents. The types of accidents, and the approximate percentages of the total number of accidents, were as follows:

	Per cent.
Hand and power-operated machinery	5½
Vehicles (except man-propelled)	10
Explosives, electricity, fires and hot substances	6½
Falls of persons	13
Stepping on, striking against or caught between objects	12
Objects falling	17½
Handling objects (including man-propelled vehicles)	15½
Hand tools (including particles set in motion by hand tools)	11
Cement and lime dust in eyes	4½
Unclassified	Remainder.

The incidence of accidents in various parts of the works was as follows.

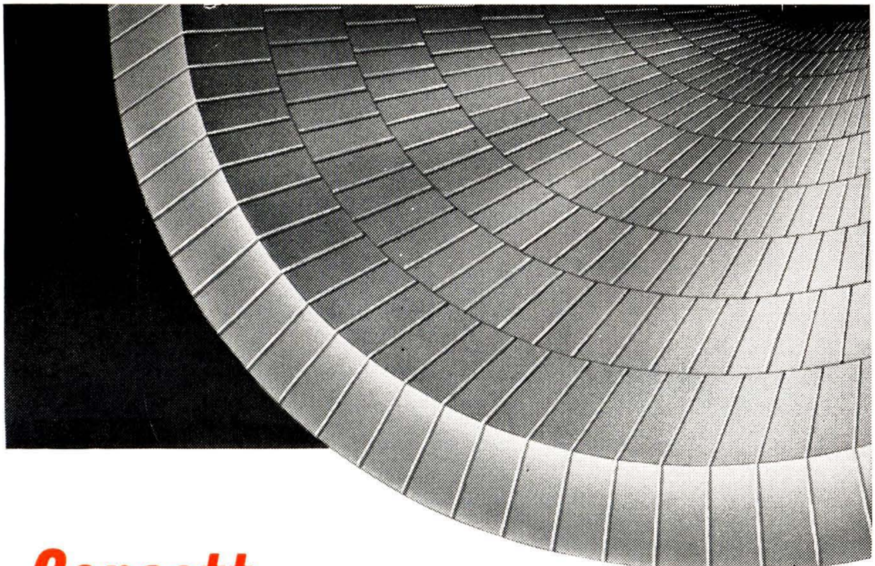
	Per cent.
Winning of raw materials	10
Preparation of raw materials	13
Clinker burning	24
Clinker grinding	13
Filling and loading	4½
Jetty	7½
Maintenance shops	3
Siding, stores and yard	13
Lime plants	3
Container plants	2
Unclassified	Remainder.

Cement Makers' Federation Advisory Committee.

The Accident Prevention Advisory Committee of the Cement Makers' Federation was inaugurated in 1950. In the first year the forty-three works participating had 550 lost-time accidents and the frequency rate was 2·00. In 1960, forty-four works had a total of 243 lost-time accidents and the frequency rate was 0·89 as reported in this journal for March last.

Industrial Safety Award.

THE National Industrial Safety Committee of The Royal Society for the Prevention of Accidents announces that the *Sir George Earle Trophy* for 1960 has been awarded to John Laing Construction Ltd., in recognition of the Company's practical and highly successful methods of dealing with the problem of accident prevention in the difficult conditions inherent in building and civil engineering work. Full acceptance of responsibilities is taken by the management at all

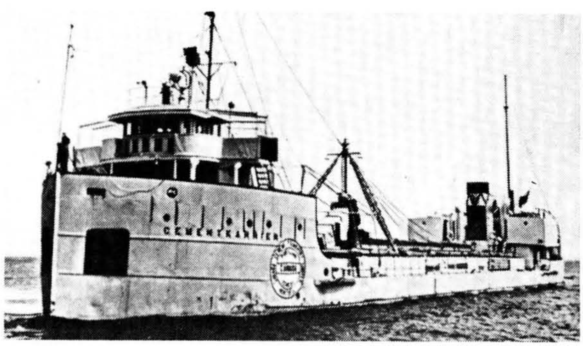


levels. Acknowledgement is made of the exceptional extent of the help readily given by the Company to further safety in the entire constructional industry.

The 1960 award was restricted to the constructional industry, one of the reasons being to bring more attention to bear on the subject of accident prevention within the industry, since the accident rate in the industry was rising. The Sir George Earle Trophy is awarded annually to the firm or industrial organization making the most significant contribution to accident prevention.

Reconstructed Vessel for Transport of Cement.

AFTER thirty years of continuous service on the Canadian Great Lakes, E.M.V. "Cementkarrier" was recently lengthened to increase its carrying capacity by about 22 per cent. to 3665 short tons. The vessel was built for Canada Cement Transport Ltd., by the Furness Shipbuilding Co., Ltd., and is fitted with electrical generating and propulsion equipment, examination of which showed that it was



fit for a further period of service without any modification. This fact is of interest because, when the ship was originally launched in 1930, it was the first built in Great Britain to be fitted with diesel-electric propulsion and electrical self-discharging equipment. The electrical plant (supplied by G.E.C. Ltd., of England) comprises two 320-kW main and two 50-kW auxiliary d.c. generators, a 775-h.p. propulsion motor, and a number of auxiliary cargo-handling motors. Modification of the vessel was carried out in a shipbuilding yard in Quebec. It involved cutting the ship in half, hauling the forward section a distance of about 50 ft., and inserting a number of intermediate sections, thereby increasing the length of the ship to about 308 ft., and its carrying capacity by 675 short tons. Other changes made to the vessel included a modified rudder and new propeller.

Prevention of Corrosion of Structures.

AN exhibition on metallic corrosion and its prevention was held during April last at The Science Museum, South Kensington, London. The exhibits were assembled by the Corrosion Group of the Society of Chemical Industry in connection with the First International Congress of Metallic Corrosion which was held concurrently in London. Some notes on the prevention of corrosion of metallic and concrete structures of the types common in cement works are given in the following.

Protective Metallic Liquids.

During the past eight years, products have been developed which have done much to combat, and in many cases to overcome, corrosion. The virtue of such products is that they are liquid metallic coatings which are applied by brush by unskilled maintenance workmen. A liquid metallic primer provides protection by metallic and electrolytic means, and has the advantage that it can serve as an undercoat for most ordinary paints or can be used in a two-coat application to provide protection from corrosive influences.

Corrosion in the cement industry may be due mainly to atmospheric moisture often with some chemical contamination. The severe abrasion caused by gritty substances adds further to the problem. Paint may not withstand such conditions, since the inherent porosity of paint allows air and moisture to penetrate and rust the underlying metal, which expands and may push off the paint; the force of expansion is estimated to be 1 ton per square inch. Iron, being an unstable metal, tends to revert to its natural state as iron ore, and to do so it needs to replace the oxygen and water lost during the smelting process; the infiltration of these substances through a paint enables oxidization to take place. Metallic coatings may withstand such corrosive conditions, since, although applied by brush or spray-gun, they solidify in contact with iron or steel and provide an impervious coating. Moisture acts as an electrolyte, binding the particles of metal closer together and causing the liquid metal to provide metallic and electrical protection.

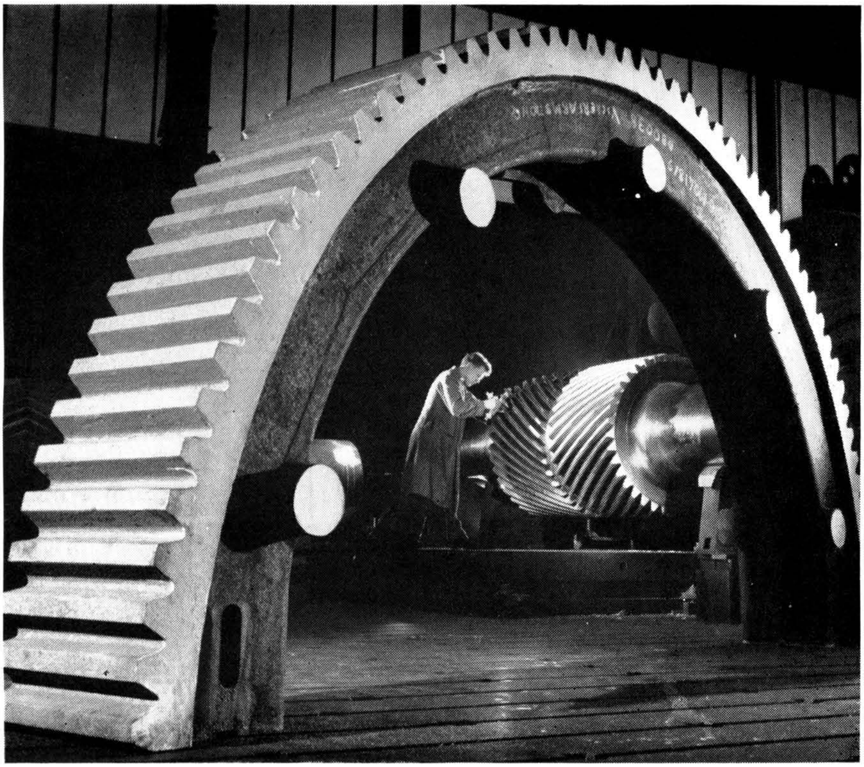
Resistance to corrosion allied with abrasion has been provided at a large quarry, where two coats of abrasion-resistant metallic coating were applied to the inside of bins and cyclones containing crushed stone.

Protection from Chemical Attack.

To combat the chemical attack which may result from sulphurous or other fumes prevalent in some parts of a cement works, a sealer which is applied over a metallic coating gives additional protection. Such sealers are in the form of a pigmented plastic skin. This system of using a metallic primer followed by an impervious plastic sealer has been used in the protection of quarry and kiln structures. On a grinding mill, a metallic coating sealed with a chemical-resistant skin proved successful for several years in conditions which caused paint to break down within a few weeks.

Protection of Concrete Structures.

Recently protection of concrete structures has been provided by means of plastic sealers used alone. A successful trial of such a sealer was carried out in



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October 1959. A sealer enriched with stainless steel was applied to the walls of a pedestrian tunnel at an airport. It is claimed that the coating is still sound and is immune to markings by pencils or similar means.

The protection of concrete by means of a paint based on a synthetic rubber resin has been developed in the U.S.A. One coat of such paint was applied to the outside of the walls of a silo in Wichita, Kansas, to provide a barrier against penetration of water and protection against the effects of intense sunlight and from erosion by wind. The silo is 120 ft. high and about 1300 ft. long. No prior preparation of the surface of the concrete was necessary. The paint was applied with pile-rollers. Employing seven men the work was completed in thirty days. The paint was developed mainly for use on grain silos but should be equally applicable to cement silos. The primary object is to provide a seal against moisture penetrating from the outside, but a film is formed that allows dampness from within to escape without peeling the coating. It is also claimed that the rubber-resin paint also provides resistance to alkalis and seals hair-cracks.

Cement Industry Abroad.

Europe.

France.—The cement works at Le Peage, near Lyons, is now supplied with natural gas from a deposit at Lacq at the foot of the Pyrenees, about 280 miles (by the course followed by the pipe-line) from the works. The company operating the gas-wells is the Société National des Pétroles d'Aquitaine.

Spain.—Euroland S.A. propose to build a cement works at Tarragona with an annual production of 300,000 tons.

A new cement works for Cementos del Noroeste, S.A., is being built near Lugo for a German concern. The daily production is to be 500 tons initially, and double this amount eventually.

Greece.—The Titan Cement Co., is to construct a cement works in Salonica with an annual capacity of 170,000 tons.

Africa.

Liberia.—An association of Italian contractors is to establish a cement works in Liberia, which, after local needs have been supplied, will be permitted to export cement.

Nigeria.—The Ewekoro works, near Lagos, of the West African Portland Cement Co., Ltd., was opened in December last by the Governor of Western Nigeria. The works, which was designed by the Associated Portland Cement Manufacturers Ltd., cost £4,000,000 and incorporates the latest developments in cement manufacture (see this journal for January 1961). The initial productive capacity will be 200,000 tons a year. Partners in the scheme, with the Associated Portland Cement Manufacturers Ltd., are the United Africa Co., Ltd., and the Western Nigerian Development Corporation.

The annual report for 1960 of the Nigerian Cement Co., Ltd., of Nkalago in Eastern Nigeria announces that demand continues to exceed production and deliveries represent 18 per cent. of the total cement consumption in Nigeria during 1959. The 300-ton kiln recently installed will, when in production, raise the output to between 17,000 and 18,000 tons a month. Cement is to be supplied by the Nkalago works to a new asbestos-cement factory to be established twenty miles away by Turners Asbestos Cement (Nigeria) Ltd.

A survey is to be conducted to determine the feasibility of installing a cement works in the Northern Region of Nigeria, where there are deposits of limestone.

Rhodesia.—In the annual report, for the year ending August 1960, of Rhodesia Cement Ltd., a decrease in sales of 60,000 tons is recorded. This position is said to be due to the political uncertainties, the restriction of Government expenditure on capital works, and the recession in the building and constructional industries. Although the cement works at Colleen Bawn operated at a reduced capacity, the lime works at Shamva and Colleen Bawn operated at full capacity and sales increased by 45 per cent. to reach 15,700 tons; most of the output of lime was used for road construction.

Transport of Cement for Llanwern Steel Works.

About 150,000 tons of Portland cement are required for the 700,000 cu. yd. of concrete for the integrated iron and steelworks of Messrs. Richard Thomas and Baldwins Ltd., now under construction at Llanwern, near Newport, Mon. The cement is delivered by rail in a train comprising twenty-one pressurised tank-wagons, each of which carries between 18 and 20 tons of cement. The train runs six nights each week.

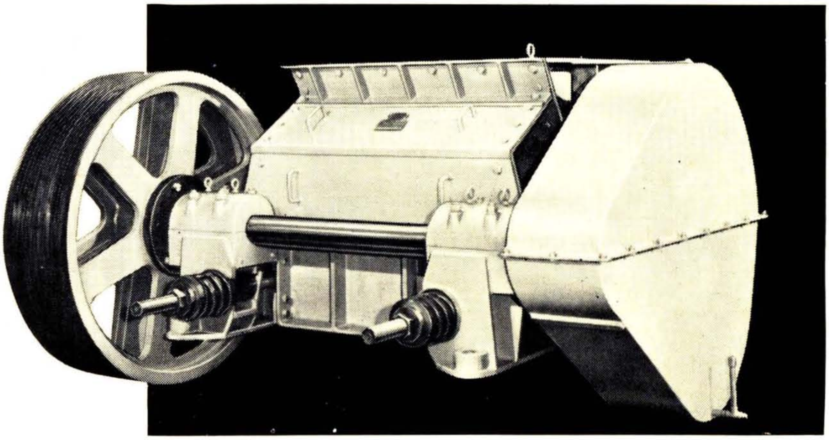
The wagons are loaded with cement in Kent and arrive at sidings at Magor, near Newport, about ten hours after leaving Erith. At the sidings, air is pumped into the wagons and the cement is blown into two silos, each having a capacity of 250 tons. The cement is conveyed by road-tankers to other silos at the batching plants on the site. The supply of cement brought by train is augmented by deliveries of about 300 tons per day by road from Rugby and Aberthaw.

There are seven main concrete batching plants on the site having an output at present of over 13,000 cu. yd. of concrete per week, but eventually the output may be over 15,000 cu. yd. per week. The contractors are Sir Robert McAlpine & Sons (South Wales) Ltd.

Patent Application for Cement.

Cement is made by feeding to the kiln a mixture of slurry made by the wet method and powder made by the dry method, the mixture having a water-content of 10 to 35 per cent. by weight. The slurry and powder are fed to a mixer before passing to the kiln, the feed of the powder being regulable in order to control the composition of the mix. Apparatus for carrying out the process comprises separate hoppers for the slurry and powder, the hoppers discharging into a mixer, in turn, discharges into the kiln, the feed of powder to the mixer being by means of a variable-speed screw conveyer.—No. 835,769. M. E. Doumet.

EDGAR ALLEN STAG SINGLE ROLL AND DOUBLE ROLL CRUSHERS



Stag Single Roll Crusher 36*in.* x 36*in.*

The Stag roll crusher is suitable for reducing coal, lump lime, and many other products from large lumps to varying sizes ranging from 6 inches to 1½ inches and under.

The crushers are made in several sizes; the smallest can deal with lumps up to 8 inches in size and the largest will take 20 inches.

We also manufacture Jaw Crushers, for rapidly reducing lumps of maximum size, Rotary Dryers for drying at the lowest possible cost, and KB Rotary Granulators for reducing large materials to approximately 1 inch.

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