Г. В. БЕРКАШ, Н. Л. ФАВОРОВА

BUILDING CONSTRUCTION

ХРЕСТОМАТИЯ ПО АНГЛИЙСКОМУ ЯЗЫКУ

ДЛЯ СТРОИТЕЛЬНЫХ ВУЗОВ
И ФАКУЛЬТЕТОВ

Издательство
ХАРЬКОВСКОГО УНИВЕРСИТЕТА

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ХРЕСТОМАТИЯ ПО СТРОИТЕЛЬСТВУ
(на английском языке).

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Корректор *Р. Е. Дорф*

Подписано к печати 16/II 1960 г. БЦ 01217. Формат 60 × 92¹/₁₆. Объем: 5,12 бум.-л., 10,25 печ.-л., 10,7 уч.-изд. л. Зак. 1416. Тираж 3000.
Цена 3 руб. 20 коп.

Типография изд-ва Харьковского государственного университета
им. А. М. Горького, ул. Университетская, 16.

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Рекомендована Министерством высшего и среднего специального образования УССР для студентов строительных специальностей вузов УССР

ИЗДАТЕЛЬСТВО
ХАРЬКОВСКОГО ОРДЕНА ТРУДОВОГО КРАСНОГО ЗНАМЕНИ
ГОСУДАРСТВЕННОГО УНИВЕРСИТЕТА имени А. М. ГОРЬКОГО
Харьков 1960

Настоящее учебное пособие представляет собою сборник оригинальных текстов по вопросам строительства.

Основная цель пособия — дать возможность студентам приобрести навыки чтения и понимания литературы по специальности, а также пополнить запас слов специальной строительной терминологией.

Тексты снабжены комментариями и англо-русским терминологическим словарем.

Данное учебное пособие предназначается для студентов старших курсов строительных факультетов технических вузов, а также может быть использовано аспирантами и инженерно-техническими работниками.

Ответственный редактор
Л. Л. Гельфенбейн.

ПРЕДИСЛОВИЕ

Исторические решения XXI съезда КПСС предусматривают гигантский рост промышленного и сельскохозяйственного производства в СССР. В 1959—65 гг. в нашей стране будет осуществлена величественная программа мероприятий в области капитального строительства, по созданию новых мощных предприятий строительной промышленности, по широкому внедрению индустриальных методов строительства, снижению стоимости и улучшению качества строительных работ.

Будет построено большое количество новых промышленных предприятий. Огромна по своему объему и намечаемая на семилетие программа жилищного, коммунального и культурного строительства. Осуществление этой грандиозной программы строительных и строительно-монтажных работ потребует значительного расширения подготовки кадров строителей и широкого использования новейших достижений как отечественной, так и зарубежной науки и техники.

В связи с этим студенты строительных вузов и факультетов, которым предстоит, по окончании высших учебных заведений, принять активное участие в реализации исторических предначертаний XXI съезда КПСС, должны овладеть иностранным языком настолько, чтобы свободно пользоваться научно-технической литературой по своей специальности.

Настоящая хрестоматия представляет собой учебное пособие для студентов строительных институтов и строительных факультетов технических вузов и призвана помочь им в разрешении указанной задачи.

При разработке предлагаемого пособия преследовались следующие главнейшие цели:

1. Дать студентам материал для приобретения прочных навыков самостоятельного чтения и перевода научно-технического текста по строительной специальности на английском языке.

2. Обогатить запас слов студентов специальной терминологической лексикой по строительной специальности.

3. Ознакомить студентов со стилистическими особенностями английской и американской научно-технической литературы по строительству.

Хрестоматия состоит из оригинальных текстов, взятых из современной английской и американской литературы по вопросам строительства. При подборе текстов был учтен опыт работы составителей по преподаванию английского языка на старших курсах Харьковского института инженеров коммунального строительства.

Тексты размещены в хрестоматии по тематическому принципу, причем их расположение в известной мере отражает последовательность изучения соответствующих тем в специальных курсах. При определении порядка размещения текстов в хрестоматии учитывался также по мере возможности принцип нарастания языковой трудности. Тексты снабжены рисунками и комментариями, облегчающими перевод отдельных, наиболее трудных предложений.

Хрестоматия может быть использована студентами не только дневных, но и вечерних, а также заочных отделений строительных институтов и факультетов. Она окажет также существенную помощь аспирантам строительных вузов и инженерам-строителям, желающим усовершенствовать знания английского языка и приобрести навыки самостоятельного чтения научно-технической литературы по строительным специальностям.

К хрестоматии приложены:

1. Англо-русский терминологический словарь по строительной специальности, содержащий слова и выражения, отсутствующие в общих англо-русских словарях на 20 тыс. слов.
2. Перечень встречающихся в тексте общепринятых английских и американских сокращений.
3. Таблица для перевода английских и американских мер в метрические.

Составители выражают искреннюю признательность преподавателям Харьковского института инженеров коммунального строительства доцентам И. М. Борщу, А. М. Беленькому и В. Д. Белогубу за ценную помощь при создании настоящего учебного пособия.

I. CEMENTING MATERIALS

LIME, GYPSUM, CEMENT

Lime, gypsum and cement are the three materials most widely used in building construction for the purpose of binding together masonry units such as stone, brick and terra cotta and as constituents of wall plaster. Cement is, furthermore, the most important component of concrete. These materials are manufactured in enormous quantities and form a very important element in all masonry structures. As a class they are designated[1] as cementing materials.

§ 1. Lime

Lime. Pure limestone or calcium carbonate ($CaCO_3$) is composed of calcium oxide (CaO) and carbon dioxide (CO_2). Limestone is, however, rarely found in this pure form, being mixed with impurities such as magnesium carbonate ($MgCO_3$), silica (SiO_2), alumina (Al_2O_3) or iron oxide (Fe_2O_3). The stones containing 90% or more of calcium carbonate are known as high calcium limestones; those containing 10% or more of magnesium carbonate are classed as magnesium limestones and those containing more than 25% magnesium carbonate are called dolomitic limestones. Commercially, lime is divided into calcium lime containing more than 70% CaO and magnesium lime containing more than 30% MgO. When the limestones contain sufficient amounts of silica and alumina the resulting manufactured lime is endowed with the ability of setting under water and is classed as hydraulic lime. Such limes are not produced to a great extent, their place being taken by[2] the hydraulic cements. It will be seen under the study of cement that its hydraulic qualities are likewise dependent upon the presence of silica and alumina in the manufactured product.

Quicklime. The manufacture of lime consists in heating or „burning" the limestone in shaft or rotary kilns to a temperature of about 900—1200° C or 1700° F. The carbon dioxide is driven off by the heat leaving CaO, calcium oxide, known as quick or caustic

lime. Quicklime is highly caustic and possesses a great affinity for water[3], readily combining with about 30% of its own weight[4]. It is shipped in lumps as it comes from shaft kilns or in the form of a coarse powder from rotary kilns.

Slaked or Hydrated Lime. When used for structural purposes quicklime is generally mixed with water or slaked*. During the slaking the water is absorbed, heat is very energetically evolved, driving off much of the excess water in form of steam, the lime bursts into pieces and is finally reduced to powder. The lime has now become calcium hydroxide $Ca(OH)_2$, and is called slaked or hydrated lime. It is ready to be made into mortar by adding water and sand to form a plastic mass. Lime is slaked at the building by putting quicklime in watertight boxes and adding water by pails or hose. The lime must be continually stirred by a shovel or hoe during the slaking process to reduce all unhydrated particles which may slake later in the building, causing popping, pitting and disintegration, especially objectionable in wall plaster. Different kinds of lime vary considerably as to the rapidity with which they react to the combining of water, the slaking process beginning and continuing more quickly with the so-called hot, fat or calcium limes than with the cool or lean magnesium limes.

After the slaking action has ceased, the lime destined for plastering, called lime putty, is run through a sieve and stored[5] for a minimum of two weeks before using. The lime to be employed in mason's mortar is not screened and need not be stored over twenty-four hours.

Mill Hydrated Lime. Lime can now be obtained slaked at the mill or kiln and is called mill hydrated lime. The proportion of lime and water and the stirring are scientifically carried out by mechanical means, and the product is very dependable. It is reduced to a fine powder and shipped in paper bags ready to mix with water and sand to form plaster or mortar.

Lime Mortar. If it were attempted to use lime as a plaster or mortar unmixed with other materials, wide cracks would occur on account of the shrinkage of the lime while hardening. Therefore sand is commonly used to mix with the lime to reduce the shrinkage and for economy of cost. The usual mixtures for mortar are 1 part of lime to 2 to 5 parts sand by volume. Water is also added to form a plastic mass which is easily workable. With a large proportion of lime the mortar is called a rich mortar, and with a large proportion of sand a lean mortar. With too much sand the mortar will work with difficulty and is said to be stiff. If the mixture will slide readily from the trowel the quality is satisfactory.

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* In the USSR quicklime is also used for structural purposes without being mixed with water. The method of using quicklime was proposed by I. V. Smirnov, the Soviet engineer, in 1940 (Composers' note).

Lime mortar will not harden under water, and in all cases exposure to air is necessary for prompt setting. The process of hardening is, therefore, slow, especially below the surface of the mortar, and in the case of high buildings rapidly erected[6] the mass of the mortar of the lower storeys does not harden with sufficient quickness to sustain the weight of the upper storeys.

Lime mortar should never be used in foundations or where exposed to moisture[7]. It is not as strong as cement mortar, although widely used before the development of Portland cement, it has now almost entirely given place to the latter. Ten per cent of the cement in cement mortar is often replaced by lime to improve the workability of the mortar. Brick is often set with a mixture of 1 part cement, 1 part lime and 6 parts sand. The greatest structural use for lime is for wall plaster.

Sand. Since sand is a large constituent of all mortars it is important that the quality of the sand should be satisfactory.

Sand is obtained from deposits such as banks and pits, from river beds and from the sea-shore. Clean bank and pit sand is best for mortar and fine river sand for plaster. Sea sand must be thoroughly washed with fresh water to remove the alkalines, which attract moisture and cause dampness in walls. Sand should be coarse, of various sizes, absolutely free from dust, loam, clay, earthy or vegetable matter and large stones. It is now considered by architects that it is not necessary for sand to be sharp and angular, as was formerly specified, but that coarseness of grain governs the quality. Coarse grains take up more lime and thereby increase the strength of the mortar. Sand should never stain the hands when rubbed, as such staining shows the presence of loam or dirt.

Hydraulic Limes. Certain limestones after burning produce limes containing sufficient free calcium to develop a slaking action and sufficient silica, iron oxide and alumina to cause them to set under water. Commercial hydraulic lime contains about 60% of lime and 25% of silica. It is burned to a sufficiently high temperature, about 1600° F., to cause reaction between the calcium and the silica and alumina, and to drive off the carbon dioxide but not to produce fusion.

Preserving Quicklime. Fresh burned lime has so much affinity for water that it will quickly absorb moisture and carbon dioxide from the atmosphere, become air slaked and lose its cementing qualities. It must, therefore, be kept in dry storage and carefully protected from dampness until used. Lump lime is more difficult to preserve than finely ground lime.

Setting of Lime. Slaked lime hardens or sets by gradually losing its water through evaporation and absorbing carbon dioxide from the air, thus changing from calcium hydroxide ($Ca(OH)_2$) to calcium carbonate ($CaCO_3$) or limestone.

EXPLANATORY NOTES

1. As a class they are designated as — Они (эти материалы) классифицируются как
2. their place being taken by — и их заменяют
3. possesses a great affinity for water — проявляет сильное сродство с водой
4. readily combining with about 30% of its own weight — легко соединяясь с ней в количестве около 30% своего собственного веса
5. is run through a sieve and stored — пропускается через сито и выдерживается на складе
6. and in the case of high buildings rapidly erected .. — и при быстром возведении высоких зданий
7. or where exposed to moisture — или там, где он (известковый раствор) подвергается действию влаги

§ 2. Gypsum

Gypsum. Gypsum is a combination of calcium sulphate with water. Gypsum is hard, fire-resistant, sets quickly and is quite light in weight, but is never used in situations exposed to the weather [1].

As found in nature the gypsum rock usually contains [2] silica, alumina, lime carbonate, oxide of iron and other impurities. Pure gypsum is known as alabaster.

Manufacture. The gypsum rock is ground fine and is heated to a temperature above the boiling point of water, 212° F., but not exceeding 374° F., when about $^3/_4$ of the combined water passes off in steam.

The remaining product is plaster of Paris if pure gypsum has been used and hard wall plaster if less than 39,5% of impurities are present or added to retard the set and improve the working qualities. The calcined material is ground to a fine powder before shipping to the consumer.

Plaster of Paris is used for cast ornamental plaster work, and it is admirable for this purpose, producing hard surfaces, sharp contours and arrises, and being sufficiently strong. It sets in 20 to 40 minutes, which is an advantage in cast work but which renders it unfit for wall plastering. Hard wall plaster, because of admixtures, has a slower set, from 2 to 32 hours, and has of late years been widely used for general plaster work. It is harder than lime plaster, sets more quickly and thoroughly and for these reasons often permits of greater speed in the construction of buildings.

If the gypsum rock be heated to 400° F. practically all the water is driven off in steam and the time of set is also much retarded. This material is finely ground and borax or alum is added to improve the workability and accelerate the set, the resulting product being known as hard finish plaster. Keene cement is one variety of hard finish plaster which is much used as wainscoting for bathrooms, kitchens and laundries, or wherever a very hard, waterproof coating is required on the walls. It is manufactured by

burning pure gypsum first to a temperature over 212° F., then dipping the lumps in an alum bath and finally drying and again heating to a temperature of 400° or 500° F., after which the product is very finely ground and screened. The resultant material sets in 1 to 4 hours and has a tensile strength of 400 lbs./in^2.

Gypsum plaster is rendered more plastic by the addition of clay or of hydrated lime. The cohesiveness is increased by adding hair or shredded wood fiber. Gypsum plaster is mixed with sand at the building before using. It may also be obtained from the producers already mixed with sand in the exact proportions best adapted to scratch coat, brown coat or finishing coat work.

Setting. The setting of gypsum plaster is not a chemical change as in the case of carbonate of lime but is due to the recombination of the dehydrated lime sulphate with water to form the original hydrated sulphate. It precipitates from the solution to form a solid mass of fine interlocking crystals. The water of crystallization is obtained from the water with which the plaster is mixed before use.

The materials added to hard wall plaster to retard its set consist of colloids such as flour and glue, which adhere around the particles of calcium sulphate. Hydration and the formation of crystals are consequently impeded and the plaster is rendered more practical for use.

Structural Gypsum. Plaster boards, wall boards, partitions, floor and roof slabs and other formed products for structural use are also made from calcined gypsum mixed with asbestos or fiber, wood pulp, cinders, sand or other materials. Plaster boards or lath consist of sheets of gypsum, either plain or perforated, with not more than 15%, by weight, of fiber, intimately mixed and pressed, or of alternate layers of gypsum and fiber. The sheets may or may not be covered on the outside with paper, but the surface must readily receive and retain gypsum plaster.

Wall boards consist of sheets of gypsum, with or without fiber, intimately mixed and pressed, and are covered with paper to form a smooth surface fit for decorating.

Gypsum Tile. Description. Gypsum partition, roof, fireproofing, floor and furring tile consist of hollow or solid gypsum blocks formed at the mill. They are used for non-bearing partitions, light roofs and floors, wall furring, vent and pipe ducts and the fireproofing of steel construction. The value of gypsum tile is due to their excellent heat-insulating qualities, their little weight and the fact that they are strong enough for light or temporary partitions and for floor and roof slabs which are not heavily loaded. They should not be used for bearing partitions or for floors and roofs carrying heavy loads. They will not withstand the action of moisture sufficiently well to make them adaptable for exterior walls.

Manufacture. As generally used, gypsum tile are * composed [3] of 97% finely ground calcined gypsum and 3% by weight of fibrous material, usually wood chips. These ingredients are mixed with water and shaped in moulds and upon drying set naturally into a fairly hard mass. The tile are either solid or hollow with circular cell spaces or cores running through them. The partition tile are rectangular, $1\frac{1}{2}$″ to 6″ thick and 12″ by 30″ in face dimensions, the tile $1\frac{1}{2}$″ and 2″ thick being most often used as furring tile. The pre-cast roof and floor tile are reinforced with wire mesh, steel bars or heavy wire.

Gypsum tile may be classified as:

(a) Partition tile, for interior non-bearing partitions;

(b) Furring tile, for furring the inside of exterior masonry walls;

(c) Floor tile, for light pre-cast floor construction;

(d) Roof tile, for light pre-cast roof construction;

(e) Fireproofing tile, for protecting steel beams, girders and columns.

Partition tile are generally manufactured of gypsum and wood chips in units 30″ long and 12″ wide (Fig. 1). Gypsum partition tile is easily sawed by hand to fit around pipes or into difficult positions [4]. It is light and easy to handle and can therefore be used in larger units than clay tile.

Furring tile may be either split tile attached to the wall by nails or be free-standing 2″ solid or 3″ or 4″ hollow tile. For furring around pipes, vent ducts and elsewhere, 2″ solid or 3″ or 4″ hollow tile are also used, depending upon the height of ceiling (Fig. 1).

Floor tile. Gypsum pre-cast floor tile are of one general type. They consist of reinforced slabs of calcined gypsum with a small percentage of softwood fiber or shavings. A very generally employed tile is 30″ long, 24″ wide and $2\frac{1}{2}$″ thick, reinforced with 6 longitudinal steel wires, $\frac{3}{16}$″ in diameter and spaced 4″ on centers.

Roof Tile. Gypsum pre-cast roof tile are made for both short and long spans. The short-span slabs are generally 12″ or 24″ wide and 30″ long. They are reinforced with wire mesh and may be either solid or hollow.

Fireproofing Tile. Columns, beams and girders may be protected from fire and heat by gypsum partition tile which can easily be cut or sawed to fit difficult angles and slight curves [5]. The sides of columns and the webs of deep beams and trusses are covered with 2″ solid or 3″ hollow partition tile. At least 2″ of protection to the steel should always be given.

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* Существительные brick, tile и пр., представляющие собой названия строительных материалов, состоящих из множества отдельных единиц, могут согласоваться с глаголом-сказуемым во множественном числе.

Erection. Gypsum mortar, composed of 1 part gypsum plaster and 2 or 3 parts by weight of clean sand, should always be used in setting gypsum tile, since Portland cement is injured by the sulphate of the gypsum.

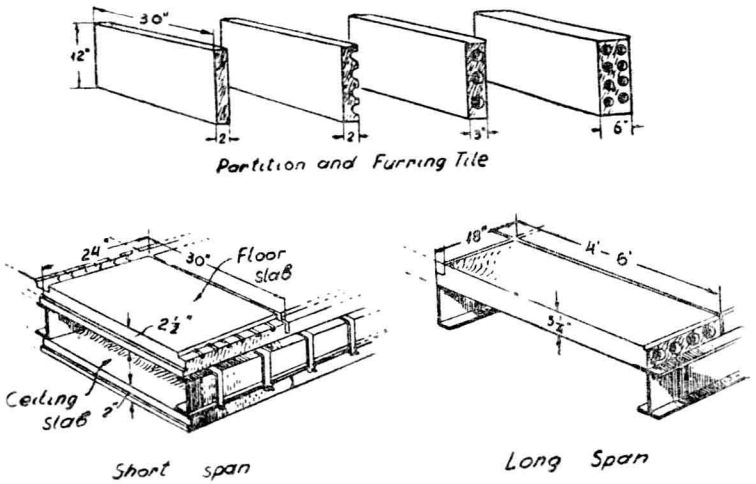

Fig. 1. Gypsum Tile.

EXPLANATORY NOTES

1. in situations exposed to the weather — в местах, подверженных воздействию атмосферных факторов
2. As found in nature the gypsum rock usually contains — В том виде, в каком гипс встречается в природе, он обычно содержит
3. As generally used, gypsum tile are composed — В том виде, в каком они обычно используются, гипсовые плитки состоят
4. to fit around pipes or into difficult positions — чтобы укладывать их вокруг труб или в трудных для пригонки местах
5. to fit difficult angles and slight curves — чтобы укладывать их в трудных для пригонки углах и на незначительных изгибах

§ 3. Cement

Natural Cement. Natural cement is made from natural rock.

The rock is usually a clayey limestone, which is burned to a sufficient temperature to drive off the carbonic acid gas [1], the clinker then being finely ground. Natural cement has hydraulic qualities but is quick setting and of relatively low strength, and is not adapted for reinforced concrete. It is consequently used only in large masses of concrete, such as dams and foundations, where weight rather than strength is a requisite [2]. Mortar made from natural cement, sand and lime is often satisfactory in laying brick and setting stone.

Portland Cement. Portland cement is a product obtained by mixing and then burning to incipient fusion two raw materials, the one composed largely of lime (CaO) and the other being a clayey or argillaceous material containing silica (SiO_2), alumina (Al) and iron (Fe). The two raw materials are ground to extreme fineness before mixing and are then mixed to give definite proportions of lime, silica, alumina and iron oxide. The mixture is then burned to incipient fusion or clinkering condition and the clinker is very finely ground. The finished product should contain, approximately, not less than 1.6 parts nor more than 2.3 parts by weight of lime to 1 part of silica, alumina and iron oxide combined. After the clinker is cooled, but before grinding, approximately 3% of gypsum is added to retard the set. The raw mix is analyzed several times each hour during manufacture to maintain the composition within proper limits. The finished product should receive no additions other than gypsum, except that not more than 1% of harmless material may be present [3]. The percentages of the principal components of Portland cement range as follows: lime 60 to 64; silica 19 to 25; alumina 5 to 9; iron oxide 2 to 4. More than 5% magnesia or 2% sulphur trioxide is not permitted. These proportions do not differ very materially from the composition of hydraulic lime, the chief difference lying in the fact that the cement is burnt to a higher temperature, which destroys the slaking qualities and generally increases the strength and hydraulic power.

Manufacture. The limestone and the clay material are separately stored and pulverized. They are first brought together in the mixing room where the components are exactly apportioned by weighing machines.

The mixture is ground once more and enters the kiln to be burned. Kilns consist of rotating sheet steel, brick-lined cylinders, 5′ to 15′ in diameter and 60′ to 250′ long. They are inclined at 15° to the horizontal.

The raw material enters at the higher end and powdered coal is blown by forced draft into the lower end. The powdered stone as it slowly progresses along the length of the kiln meets an ever-increasing heat until it is fused into clinkers at the lower end of the kiln. It is then removed to the cooling rooms and after cooling is mixed with a small proportion of gypsum (2 to 3%) to retard the initial set of the cement. The clinker is finally ground to an extremely fine powder and goes to the finished cement storage bins [4]. Fine grinding greatly increases the strength of the cement by improving the conditions for complete hydration (Fig. 2).

Masonry Cement. Cements have been developed for use in mortars for laying unit masonry such as brick, structural tile and building blocks. They are not as strong as standard Portland cements, but since their characteristics include easy workability, high water-retaining capacity, plasticity and accurate set, and because their cost is less, they are widely used when their com-

pressive strength is sufficient. Waterproofing material is often added during manufacture to produce greater density and to prevent efflorescence.

Non-staining Cement. Ordinary Portland cement will stain limestones, marbles and other light-colored stones when used in the mortar with which the stone is set. Lime free from iron

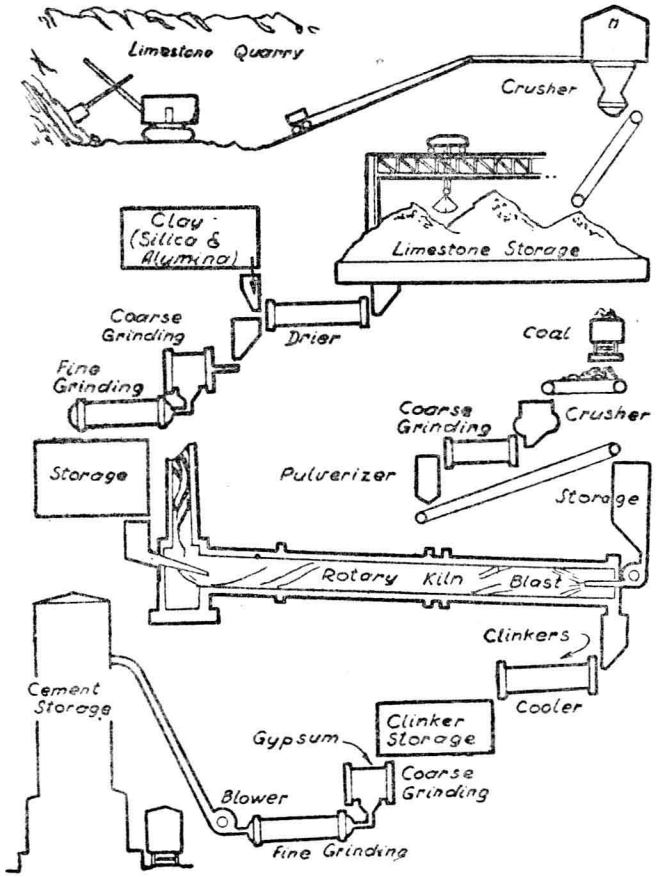

Fig. 2. Cement Manufacturing.

oxide makes the best non-staining mortar, but to gain greater strength non-staining cements have been developed. White cement free from iron oxide and water-soluble alkali is now widely used for setting light-colored stone and for making stuccos and artificial or cast stone.

High Early Strength Cement. For some purposes it is distinct advantage to use a cement with the ability to attain a higher early strength than is the case with the ordinary cement. This is particularly true in concrete road making, floor and machine

base construction, and in concrete building carried on in freezing weather.

Such cements are now widely used but are as yet slightly more costly than standard Portland cement. They are of two general classes: firstly the high alumina cements made from a melted mixture of about equal quantities of limestone and an aluminium ore called bauxite; and secondly the accelerated Portland cements, frequently termed „supercements", which have a high lime ratio, are very finely ground and are burned at higher temperatures than ordinary cement. The compressive strength attained by a quick-hardening cement concrete in 1 day is approximately equal to the 28-day compressive strength of a standard cement concrete of similar proportions.

Portland Cement Mortar. Mortar is a mixture of cement, sand and water to form a plastic workable mass. It may be mixed by hand or by mechanical mixers, the mixers being preferable for large quantities. Mixing by hand is done on watertight platforms, the cement and sand being first thoroughly shoveled together in small quantities in the required proportions and rendered completely homogeneous before the water is added.

After adding the water the whole mass is then remixed until the hoe or shovel appears clean and bright when drawn out of the mass. Mortar should be fairly stiff and not too thin or wet, and should not be used later than 4 hours after mixing. The usual proportions are 1 part cement to 3 parts sand for ordinary work, and 1 part cement to 1 or 2 parts sand for top surface of floors and sidewalks. A very satisfactory mortar for brickwork consists of 1 part Portland cement, 1 part lime and 6 parts sand.

Effect of Temperature. Very hot or dry weather causes the water in the mortar to evaporate too quickly. Stones and brick should consequently be thoroughly soaked in such weather so that the mortar will not be reduced to a powder. In cold weather the mixing and placing of all mortar are generally difficult, and lime and natural cement mortars are materially injured by alternate freezing and thawing. Mortar composed of 1 part Portland cement and not more than 3 parts sand is, however, very little injured by the effects of freezing weather. Where heating facilities can be obtained it is possible to improve conditions by using high early strength Portland cement and by heating the water, sand, brick and stone. Under such conditions work is frequently carried on all winter in northern climates without delays.

EXPLANATORY NOTES

1. which is burned to a sufficient temperature to drive off the carbonic acid gas — который обжигается при температуре, достаточной для того чтобы выделился углекислый газ.
2. where weight rather than strength is a requisite — где требуется скорее вес, чем прочность.

3. The finished product should receive no additions other than gypsum, except that not more than 1% of harmless material may be present — В готовый продукт не следует добавлять ничего другого, кроме гипса, но возможность присутствия в нем не более 1% безвредных примесей не исключается.
4. and goes to the finished cement storage bins — и поступает в бункера для хранения готового цемента.

II. CONCRETE

§ 1. Composition of Concrete

Our two most important building materials may now be considered to be [1] structural steel and concrete. For foundations, footings, basement walls and fireproof floor construction, the use of concrete is almost universal, while the number and importance of the buildings whose columns, girders, beams and walls are entirely of concrete are rapidly increasing with each succeeding year.

Definition. Concrete may be considered an artificial conglomerate stone made by uniting cement and water into a paste and mixing into this paste a fine material such as sand and a coarser material such as broken stone, gravel, slag or cinders. Upon the hardening of the paste the entire mass becomes like a solid stone. Mass concrete was employed by the Egyptians and the Romans, but the use of steel reinforcement did not begin until the nineteenth century of our era [2].

Because of its composition concrete has great compressive strength but little ability to withstand tension. Steel bars, rods or mesh fabric are consequently incorporated in those parts of the concrete members where it is required that tensile stresses be resisted. Concrete may, therefore, be divided into two classes: mass concrete, where weight or bulk is required and where to a large degree only compressive stresses are present; and reinforced concrete, where it is necessary to introduce steel into the body of the material to counteract the tensile stresses caused by the nature of the existing loads.

Matrix. The chemically active element of concrete is the cement, sometimes called the matrix. It becomes hydrated, that is, united chemically and physically with the water, and produces what may be termed a glue, binding the sand, stone or other coarse material together.

Aggregates. The remaining ingredients of concrete besides the cement and water, that is the sand, broken stone, cinders, slag, etc., are chemically inert and are classed as the aggregates. The material under $^1/_4$″ in diameter is designated as fine aggregate and generally refers to the sand. All material over $^1/_4$″ in diameter is called coarse aggregate and includes the broken stone, cinders, etc. Any crushed rock or slag of durable character, or any clean, hard, natural gravel, may properly be used as coarse aggregate. Granite,