MINERALOGY

Air Makes Concrete Lighter

Taller and less expensive buildings are now possible with this new lightweight material, since it will eliminate much dead weight.

By MARTHA G. MORROW

See Front Cover

➤ CONCRETE is being made lighter these days simply by getting more air into it. Some is so light it floats on water.

Lightweight concrete makes possible taller and less costly buildings.

Designed to eliminate much of the dead weight in buildings, concrete made with such air-filled aggregate as expanded perlite and pumice weighs only a fraction as much as that employing the traditional sand, gravel and crushed stone.

Air also is whipped into the mortar. This is done by using air-entraining agents such as tallow and resin. Concrete made in this way is less affected by freezing and thawing.

Some air is normally trapped in concrete, ordinarily about one percent. That incorporating from four to six percent of air can more effectively resist disintegration caused by repeated freezing and thawing. studies at the National Bureau of Standards indicate.

Easily Molded

When air-entraining agents are used, the concrete can be molded much more easily and less water is needed in the mixture. Themselves water-repellent, they tend to make the particles in the concrete mix more uniformly. Such concrete, however, does not adhere to steel reinforcement quite as well as regular concrete.

The foaming agent can either be ground into the cement at the mill or be added at the time of mixing. Such materials as tallow, certain types of resins, lime stearate and waste liquor from sulfite paper mills have been used successfully.

Lightweight aggregate concrete also can be made more workable and more resistant to freezing and thawing by entrapping air. As much as 15 or 20% of air is incorporated.

The need for lightweight building materials was emphasized toward the end of the last century when building design changed from thick, heavy, load-bearing walls such as brick or stone to a framework of structural steel beams and columns with thin walls, and then to reinforced concrete.

Ordinary concrete such as you find in sidewalks and highways is heavy. Using sand and gravel as the aggregate, it weighs about 150 pounds per cubic foot. It can be made strong and durable, but there are many instances where such a heavy concrete is disadvantageous.

Concrete using a lightweight aggregate makes it possible without additional weight to construct higher buildings, or to add several stories to buildings already existing that could not safely support a greater weight. Also less structural steel is needed, so the total expense of the building can be cut enormously.

The term "lightweight" was first applied to concretes using expanded clay or shale as an aggregate. Such concrete weighed about 100 pounds per cubic foot. In recent years, however, a satisfactory concrete weighing as little as 25 to 50 pounds per cubic foot has been produced by using such mineral aggregates as expanded perlite and expanded vermiculite.

Concrete blocks using lightweight aggregates have many of the same characteristics, but in varying degrees. Most of them can be sawed and nailed like wood, and give good insulation against heat and sound.

Expanded vermiculite produces an excellent concrete for roofing or insulation, but possesses little structural strength. The mineral itself is a special type of mica that expands when heated. It has about a million extremely thin layers to an inch. Between each layer is a tiny amount of water. When flakes of the mineral are heated, the minute layers open out to about 15 times their original size.

To produce the golden bits of expanded vermiculite, the mineral is dried, ground and heated to about 1,800 degrees Fahrenheit for only four to eight seconds. Only recently has expanded vermiculite been used in lightweight concrete weighing one-third to one-sixth as much as regular concrete.

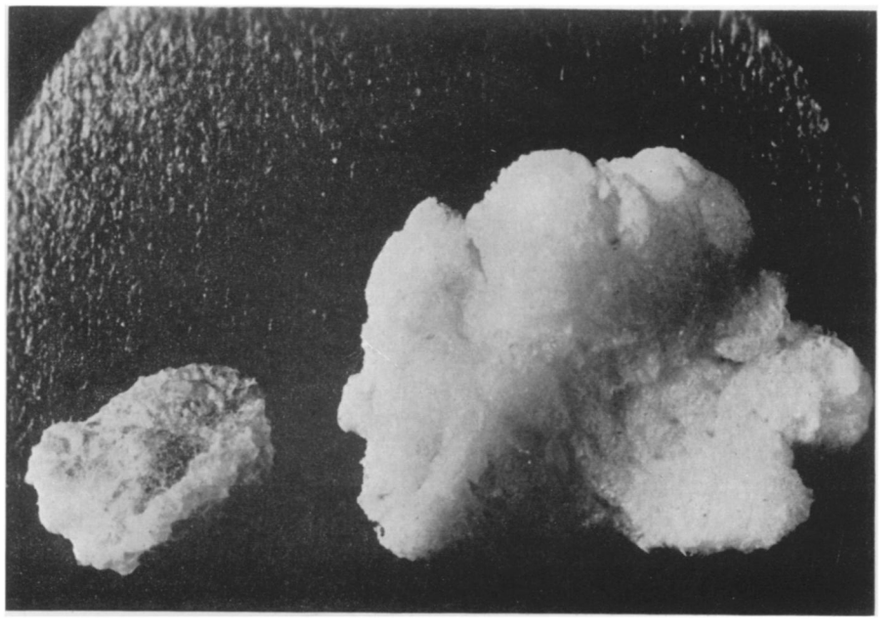
Vermiculite concrete is so light it floats on water, while concrete made with the traditional sand and gravel aggregate sinks, as shown on the cover of this week's SCIENCE NEWS LETTER.

Volcanic Glass

Expanded perlite, a natural volcanic glass, is used for a concrete with excellent insulating qualities. It is not considered well adapted, however, to construction where high strength is required. Concrete made from it weighs as little as 40 to 65 pounds per cubic foot.

Perlite usually is a soft pearl-gray in color. Although known for many years, its commercial production as a lightweight aggregate for plaster and concrete is relatively new.

Perlite is three-fourths silica, the principal constituent of sand. It is permeated with tiny pockets of entrapped water. When the mineral is crushed and heated



PUFFED MINERAL AIDS BUILDING—Perlite is mined as a compact mineral, as shown at left, but when it is ground and heated, water inside the rock forms steam which puffs it out (right).

EXPANDED MINERAL—Featherweight vermiculite, excellent for roofing or insulation, weighs only about a tenth as much as sand, being measured at right.

red-hot, the water turns to steam and puffs up the material so it contains minute air cells.

Nature put the air cells in pumice. Related to perlite in origin, this solidified froth was formed a little farther out from the volcanic core. Pumice is used to make a strong concrete weighing 60 to 90 pounds.

Pumice is the result of violent eruptions. The material from which it was created was almost completely liquid when forced out of the volcano. It cooled so fast that there was no time for the melted rock to crystallize. The vapors dissolved in it were suddenly released and the whole mass swelled up into a frothy mineral which hardened.

The use of pumice in building goes back to the days of the Romans. Fragments of pumice were employed as aggregate to reduce dead weight in many of the great domes such as the Pantheon and of the immense vaults of the public baths in Rome.

Slag, produced in the manufacture of pig iron, is cooled from the molten state with water to produce a sturdy, cellular material. The heat of the slag instantly turns the water into steam which, expanding enormously, puffs or "foams" the slag. Practically all of the water evaporates and the expanded slag incorporates only a small amount of moisture.

Foamed slag weighs only about half as much as does air-cooled blast-furnace slag. The concrete using it as an aggregate weighs approximately 80 to 100 pounds per cubic foot. In 1947 a million and a quarter tons of foamed slag were used for concrete.

Some types of clay, shale and slate are heat-treated to form a lightweight product. After being taken from the bank or quarry, the material is reduced to a proper fineness, then dumped into a rotary kiln. Here it softens to the consistency of chewing gum. As it is heated at a temperature greater than 2,000 degrees Fahrenheit, the material expands greatly.

This expanded material is one of the most widely-used lightweight aggregates. Created under intense heat, it is particularly good for use in concrete that may be subjected to extremely high temperatures.

Cinders, left from coal or coke that has

Do You Know?

The protein and mineral contents of *fishery foods* are equal to those of meat.

Ascorbic acid, which is vitamin C, may be added to fruits being canned in the home to prevent them from turning brown or developing an off flavor.

Tetanus, or lockjaw, is not caused by a rusty nail as many believe but by a germ that is often present in soils contaminated by the body wastes of cattle, horses and other animals.

The service life of *fence posts* of common non-durable woods can be doubled if they are treated before set in the soil with such preservatives as copper naphthenate, creosote, zinc chloride or pentachlorophenol.

The *highland flower mouse* is a rat-like rodent of Nepal, the Himalaya nation north of India; it lives in grass nests in hollows in decayed trees.

been burned, are mixed with sand to form a concrete that weighs 35 to 40 pounds less per cubic foot than regular concrete.

Each lightweight aggregate has certain distinct characteristics. If insulation is the primary consideration, then expanded vermiculite is the choice. If insulation is important and some structural strength is required, then perlite is often preferred.

When great strength is essential as well as light weight, pumice, foamed slag, expanded clay and shale, or one of the other strong but air-filled aggregates will be called into service. Here the availability of the material may be the determining factor. Pumice, for instance, is widely used on the Pacific Coast, where it is found in certain volcanic regions. Foamed slag is popular in the East and Middle West, where large numbers of blast furnaces are located.

These and many other promising lightweight aggregates are being thoroughly tested as to insulation against heat and sound, strength, ability to withstand repeated freezing and thawing, and other important qualities. This is done by the National Bureau of Standards and the Bureau of Reclamation under the sponsorship of the Housing and Home Finance Agency. From such studies will result better office buildings, apartment houses and homes in the future.

A number of these lightweight extenders have been collected for you by Science Service. For the nominal fee of 50 cents you can receive specimens of expanded shale or clay, pumice, perlite ore and expanded perlite, vermiculite ore and expanded vermiculite. These are accompanied by a number of interesting experiments you can perform with the aggregates. Write Science Service, 1719 N St., N. W., Washington 6, D. C., and ask for the kit of lightweight aggregates.

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ASTRONOMY

Comet Ashbrook Brighter

➤ COMET ASHBROOK, spotted a few weeks ago in the constellation of Aquarius, the water carrier, is increasing in brightness. But it will probably never become bright enough for you to see without the aid of at least a small telescope.

The comet will make its closest approach to the sun next April 25, and will be nearest the earth the end of this month, calculates Dr. Allan D. Maxwell of Howard University, Washington. On Sept. 30 the head of the comet will come within 218,000,000 miles of the earth, he estimates; this is also the distance it will be from the sun on its nearest approach.

Now visible in the southeast, the comet was spotted on Aug. 26 by Dr. Joseph Ashbrook of Yale University Observatory while at the Lowell Observatory, Flagstaff, Ariz. It was of the 12th magnitude when found.

The comet will probably never become brighter than 10th or 11th magnitude, Dr. Maxwell says. It will reach its maximum brightness in March and April of next year, but at that time the sun will interfere with our seeing it.

Now 10 to 12 degrees north of the bright star Fomalhaut, the comet is moving so slowly that it will not leave the constellation of Aquarius until early next year. Just missing the constellation of Pegasus, the winged horse, it will swing into the constellation of Pisces the fishes, and on into Aries, the ram.

By the end of June it will be in the vicinity of the star Capella, of 0.2 magnitude and hence one of the brightest in the sky. During September of next year it will be in the constellation of Gemini, the twins. This is about as far north as it will get.

The best time to look for the comet is in the early morning hours, about one or two o'clock. On Wednesday, Sept. 22, it will be found at right ascension 22 hours, 48.8 minutes; declination negative 13 degrees, 39 minutes, Dr. Maxwell reports. On Thursday, Sept. 30, look for it at right ascension 22 hours, 42.2 minutes; declination minus 13 degrees, four minutes.

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