PERLITE

By

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With the start of reconstruction work after the terrible devastations of World War II and because of growing special demands, building activity has increased rapidly all over the world. With the necessity to speed up the process and to simplify the task of construction, search for new light-weight materials having at the same time favourable heat insulation and sound reduction properties, has become a matter of utmost urgency. A series of new building materials has been developed: to mention only the most important ones, quenched blastfurnace slag, foamed slag, fly ash, expanded shale and last not least expanded perlite. These new building materials had to meet requirements not to be complied with by conventional building materials: they were expected to show effective heat insulation and sound reduction, and to combine lightness of weight with reasonable strength, and their production costs had to remain within the limits set by economic considerations. Not each of these building materials, of course, has met all of these conditions to the same degree. It was perlite that proved to be the foremost in accord with these requirements and this is why the attention of the building industry has centered on this raw material all over the world. As building material it first has been adopted in the USA only as recently as about 1944. Its application as raw material, however, goes back as far as 1810, when it was used as a component of the batch by the Italian glass industry (petroselce perlata). In 1836 a wellknown geologist gives the following description of perlite: "It expands in a flame to nearly such extent as borax; the dark variety discolours", and he predicted a wide field of application for this material. For building purposes it has been adopted only in recent years in Italy itself. In Germany experiments were carried out as early as in 1925 already, but here its application for building purposes started only in 1955. In the Soviet Union the first experiments go back to the period of 1936—39. In 1955 the Tyeploproject National Scientific Research and Planning Bureau carried out prospecting of deposits in the Soviet Union and developed processing methods for the individual varieties to be used as light-weight aggregates for heat-insulating and sound reducing materials.

In Hungary the utilization of perlite as building material was first suggested by J. Hevesi, member of the Academy of Sciences. Practical perlite expansion and utilization in Hungary got a strong stimulus by the establishment of the expansion plant in Nyiregyháza which was on stream by the end of 1958, and its keen, young technical team attained some good results already. The starting up of this expansion plant, however, is only the first step in the field of perlite expansion and utilization, and production will be taken up within a short time by a series of new works.

It was stated by Bunsen and Soddy that in volcanic glasses solidified from siliceous lava, particularly in such containing over 70 per cent silica, dissolved or combined water can be detected. This water content is due to rapid increase of viscosity of the melt on account of sudden cooling which inhibited both crystallization of the melt and release of water. They further stated that these rocks when heated rapidly to about 900—1100° C (1650—2000° F) expand to a multiple of their original volume while losing their water content. This statement is a hint actually to the fundamentals of today's technology of processing.

Known perlite deposits are of similar chemical composition as shown by the following table; it should be pointed out, however, that even perlites of about identical composition expand at different temperatures and in different ways. For each perlite variety, therefore, a special schedule of the expansion process has to be developed.

A wide variety of furnaces is used for the expansion of perlite, such as shaft kilns, rotary- and fixed drum kilns and even roasting furnaces with fluidized material bed. As mentioned before, a special expanding procedure has to be applied for each perlite variety. The individual processes differ inasmuch as velocity of passage of perlite through the firing zone, flame temperature, excess of air are different, in some cases the raw material is preheated, in some others there is no preheating. In order to obtain a uniformly expanded perlite suitable for particular purposes, it is advantageous to feed crude perlite into the kiln in fractions within narrow ranges of size. The technology of perlite expansion proceeds in the following order: crushing and screening of the crude perlite followed incidentally by preheating to at most 400° C (750° F) and expansion in a suitable kiln, cooling, classifying by screening or rather by air-elutriation and finally bagging of the finished products. Temperature of expansion varies within the range of 950 to 1250° C (1650 to 2180° F).

Fairly good expansion and in consequence satisfactory heat insulating capacity is a function of that portion of water content which is chemically combined in a way that it escapes at such temperature where the fundamentally vitreous substance of the rock is to a certain extent in the plastic state already, when heated suddenly to a temperature being in accordance with the individual properties of the raw perlite to be expanded, water is released in form of vapour and the remaining substance of the perlite grains being in the state of plasticity, become considerably inflated. Owing to this particular feature of perlite, as a result of such heat treatment, innumerable small sealed pores are formed in the grains of originally dense structure, and they expand to the 10—15-fold of their original volume In consequence of the energetic action o· the rapid vapour development, breakdown of the expanded grains to some extent is inevitable, and thus the majority of them disintegrate into fragments of different sizes. Nevertheless, the resulting expanded particles are partly still of considerable dimensions and their diameters vary from zero to several mm-s in dependence on their original size. In order to be able to combine the required granulometric composition of perlite aggregates, the expanded product is often graded into several fractions of different size.

Chemical analysis of raw perlites

Origin	SiO_2 %	Al_2O_3 + TiO_2 %	Fe_2O_3 %	MgO %	K_2O %	Na_2O %	H_2O %
Hungarian from Pálháza	73,6	13,4	2,0	traces	3,1	2,4	3,7
American "John-Clare"	69,8	14,7	2,1	1,1	4,0	2,8	4,0
Soviet from Bogopol	72,0	12,6	0,8	0,47	1,7	4,07	1,88
Soviet from Sergejew	72,5	13,7	1,3	0,31	4,2	2,6	2,2
Italian	70,7	15,8	2,0	besides further different oxides			

Bulk density of expanded perlite shoveled loosely into a container is from 70 to 130 kg/cu. m. (4.35 to 8.1 lb/cu. ft). Average thermal conductivity at room temperature in the same state is about 0,04 kcal/m/hour/°C (0,32 B. Th. U. in./sq. ft./hour/°F). Expanded perlite can safely be exposed to temperatures up to about 800° C (1470° F) without any noticeable changes in its structure. When appropriately annealed, expanded perlite shows excellent resiliency and comparatively adequate strength to resist crushing action of the mixing procedure without breakdown of the individual grains. This characteristic of expanded perlite is called hardness and is determined by compacting the sample in a 3″ dia. × 5″ cylinder under compressive load. Hardness is considered as the applied specific load necessary to attain 1″ compacting of the originally 5″ height of the sample. Required minimum hardness for concrete aggregates is 5,3 kg/sq. cm (75 lb/sq. in.). Mixed with a binder its resistance to fire is substantially higher than that of many other building materials. When dry, expanded perlite shows high electric resistivity. This property, however, has not been exploited as yet. Owing to its anorganic character and to the absence of any organic matter, it is not subjected to moulding or putrefaction. Perlite is chemically fairly inert and does not attack other materials unless transformed into melt by excessive temperatures. Having low thermal conductivity, no condensation of water vapour occurs on the inside surfaces of walls or ceilings insulated with perlite.

Expanded perlite in loose form or bounded as aggregates is a poor transmitter of sound vibrations and thus provides effective protection against solid-borne noise. It is at the same time an excellent sound absorber and reflects only a small portion of airborne sound preventing in this way any noticeable rise of echo. Owing to these outstanding features, it is an excellent sound reducing building material both in the way of sound insulation and protection against creation of inconvenient echo.

The most simple application of expanded perlite as building material is its use in loose form for heat insulating purposes. In such cases it is filled in cores of blocks or other voids in the structure or placed on floors under floating estrichs, on roofs under the finishing layer etc.

The most extended application of expanded perlite is its use as light-weight aggregates in concrete mixes either exclusively or along with other aggregates — light-weight or common. When used for insulating concrete, it is usually the only aggregate. In order to reduce the weight of structural concrete it is often added as one of the aggregates to mixes for such concrete. In both cases concrete mixes are either used for prefabrication of blocks, slabs, panels etc. or placed on the site with or without reinforcement. When perlite concrete is used for prefabrication, it is often advantageous to perform curing by treatment with steam of atmospheric or elevated pressure.

Expanded perlite is used also extensively as a component of gypsum plaster in which case it is applied as coating on inside surfaces of walls and ceilings either poured or troweled directly upon the structural element or with the aid of metal lath, wire fabric or other means providing rigid adherence.

Solution of sodium silicate and clay are also bonds for perlite, and in case of application of the latter, bricks etc. formed of mud compounded of expanded perlite, clay and water, have to be subjected to firing similarly to common bricks in order to acquire sufficient strength and insensibility to the softening action of water.

Both prefabricated and placed in situ perlite concrete serves as heat insulation on sidewalls, floors and roofs. The purpose of such heat insulation is not always reduction of heat losses from the inside of the building but very often — especially in southern regions — protection against radiant heat of the blazing sun. Perlite concrete is also an excellent means for insulating refrigerators and large cold storage localities.

The excessive light-weight of expanded perlite renders it an excellent aggregate alone or combined with other aggregates for structural concrete. In this line partition walls are erected of perlite concrete, core blocks, reinforced slabs and panels of large dimensions are prefabricated. Panels are preferably reinforced by imbedded corrugated steel core and welded wire mesh, all edges being steel framed. The use of structural perlite concrete reduces considerably the dead weight of constructions and at the same time reduces heat losses and sound vibrations all over the building.

Prefabricated perlite concrete and gypsum plaster can be sawed and drilled without chipping and cracking, and nails can be driven easily into and held firmly by them.

Perlite concrete and perlite gypsum plaster is used also as means of effective sound reduction both in the way of insulation against the penetration of outside noise and of sound absorption to improve acoustic conditions in large auditoriums.

Owing to their low thermal conductivity and incombustibility, perlite concrete and perlite gypsum plaster give effective protection against fire hazards.

Although its principal application is in the building industry, there are many possibilities for the utilization of expanded perlite in various other fields as well.

In the agriculture it is used for the loosening of soils, for the cultivation of young seedlings and for the packing of bulbous plants to be delivered at great distances, for protection of grains against weewills etc.

The application of expanded perlite in the chemical industries is gaining ground steadily. It serves as carrier of fertilizers and catalytic agents, as filter aid in the dry-cleaning, brewing, sugar refining and distilling industries as well as in oil refineries. It is used as filler in rubber, paint, soap, plastics and resin binders.

It has been found to be of excellent suitability as a cement slurry additive in the well drilling line, because, owing to its resilience and excellent workability it gives the setting cement slurry such properties which reduce effectively strata-crackings and perforations of sharper outlines are obtained.

The prominent heat insulation properties of expanded perlite are extensively exploited in many industrial branches. So for instance, in the steel industry when delays in pouring are inevitable by placing perlite on top of the contents of ladles, cooling down of the molten metal and slag is prevented effectively. It is used also to form risers in casting diverse metals, and it keeps the metal in fluid state for a considerable space of time.

Expanded perlite is also used as an abrasive for polishing purposes.

Its resilience and light-weight qualify it as an ideal packing material in numerous instances.

It can be seen from the above said and the reported technical data what wide horizon is opening up for the application of expanded perlite. At present, though in Europe relatively slowly, due to its multifold outstanding properties, expanded perlite is attaining year by year greater importance. This prominence among the series of conventional and new building materials is to be attributed to these excellent properties, and most certainly to advantageous economic considerations in connection with its application as well. Perlite is nowadays in sharp competition with cork already and in many respects also with vermiculite.

A kiadásért felel az Akadémiai Kiadó igazgatója Műszaki felelős: Farkas Sándor
A kézirat nyomdába érkezett: 1959. IX. 30. — Terjedelem: 4 (A/5) ív, 39 ábra

1960.50058 — Akadémiai Nyomda, Budapest — Felelős vezető: Bernát György