

## Using Sarbisheh (Iran East) Perlite as Initial Material of Producing Expanded Perlite in Building Industry

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Received: March 19, 2015

Accepted: May 2, 2015

### ABSTRACT

Perlite is acidic rich volcanic rock made by watery glass (about 2 to 5%) in their combination. Its embodied water is evaporated by heat between 900°C to 1100°C; as a result, its volume increases fourth to twenties times, its specific gravity decreases, and it changes to white grains. Specific gravity of expanded perlite are 0.1 to 0.25 gr/cm<sup>3</sup> and its heat conductivity without water is 0.046 w/m°C to 0.06, so the best kinds of insulators have been used to absorb heat and noise that is the easiest and the most economics method of utilizing energy nowadays. Products such as reinforced concrete (mixture of Portland and expanded perlite), prepared lined up (mixture of perlite and plaster instead of traditional materials), preparing perlite mixture with tar materials to cover roofs and preparing expanded perlite for floors are substantial samples of using perlite in building industry. The main problems of perlite concrete are their low resistance so adding micro-silica increases its compressive strength; in addition, high absorption of water reduces perlite viscosity significantly.

**KEYWORDS:** expanded perlite, thermal conductivity, insulator, perlite concrete

### 1- INTRODUCTION

Using natural low-weight materials has been considered as a proper solution to reduce dimensions of porter structure and to minimize earthquake force and to run building with lower weight and proper heat and noise insulator.

Lightening building weight includes reducing building weight using new materials and optimizing implemented methods which are reinforcing methods against earthquake; as though, inserted force on building by earthquake has direct proportion to building weight. As much as weight of structural and non-structural parts of building reduces, building vulnerability reduces, more. Reducing weight of building leads to reduce dimensions of structural elements and reduce costs of building structure.

- Perlite: perlite is a certain area in geographical map 1:100000 Sarbisheh (10 km to northwest of Sarbisheh) and located at east margin of Lut block (figure 1 & 2). Perlite is glass volcanic rock with rhyolite compound having 2 to 5% trapped water. Proper industrial perlite has more than 65% silica and average water of 2.5%.

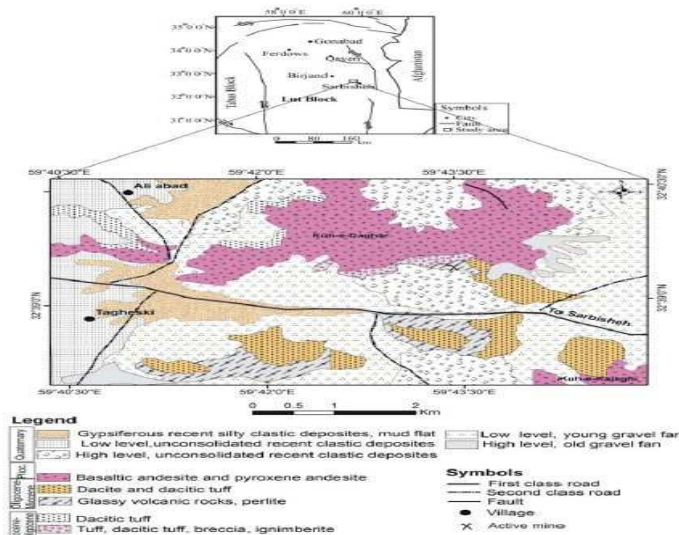


Figure1. Geological map of studied area with perlite mineral range



Figure2. Dessert picture of volcanic-pyroclastic rocks compassing 3 layers perlite (A, B, C)

- **Perlite processing:** processing of mashed and grained perlite includes swelling in high temperature and changing into bubble materials. When perlite is heated fast to initial melting temperature of 900 to 100°C, it is expanded by making vapor and make white porous material with low massive density about 30 to 240 kg/m<sup>3</sup>. Concrete made by perlite has very low resistance and high accumulation. It is mainly used as insulator against heat.
- **Perlite properties:** perlite is used as initial material in building industry for its important properties. Some of them are as following:
  1. **Heat connectivity coefficient:** factors such as shape, size of pores, pores being opened or closed and their frequency are effective on heat conductivity.
  2. **Sound insulator:** foe being hollow in appearance, it absorb sound. Sound absorption coefficient in perlite in 125Hz is 0.18 and in 400Hz, it is 0.9; it means as much as sound is louder, absorption becomes more.
  3. **Resistance against fire:** perlite is non-flammable substance.
  4. **It is non-organic** substance and doesn't react with most of acids; moreover, it is resistant against decay.
  5. **Granulation:** perlites with 2.5 to 5 mm diameter are used in building industry; as though, increase in grain diameter reduces specific gravity and heat absorption.
  6. **Resistance against humidity:** according to porous structure and connected pores, perlite has water in 10 to 30% of its weight which is on of defect for this substance.

## 2- METHODOLOGY

Perlite has been mentioned as important for its 2 important application in building, one for being insulator as the best one among other insulators in absorbing sound and heat conductivity and second for being row material producer of light building materials to lighten structure which has been mentioned significantly according to be economical, fast implementation of building, and reducing target costs and dangers made by earthquake.

Perlite is used in 2 forms in buildings:

### 1- Solid expanded perlite:

The best and easiest way for heat isolation is using solid expanded perlite. These perlites are poured in pores of blocks and bricks. In these isolations 50% of heat transfer coefficient is reduced. Whenever this kind of perlite is mixed by silicon and used, heat transfer coefficient becomes less than 50%. Expanded perlite should have specific gravity of 80-130 kg/m<sup>3</sup> to have isolation. In figure 3, density approximate range and made concrete's resistance with various light grains have been compered.

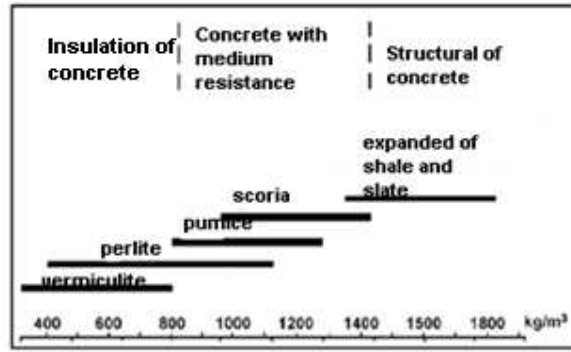


Figure3. Approximate range of density and made concrete resistance with various light grains.

**2- Expanded perlite with combination of cement or plaster as concrete or pre-constructed:**

Expanded perlite has been mostly used for the following purposes in building sectors:

**2-1- Using expanded perlite in light concrete:**

All types of light pre-constructed concrete from perlite are used in non-porter systems and are mostly for isolation, being light and resistant against firing. For example, in filling building floor mixture of perlite and sand is used to reduce by dead load. Therefore, using these concrete we can reduce dead load up to 50% and also these are noise isolated in floors and ceiling. Perlite concrete is 20 times stronger in heat insulating than ordinal concrete. This fact reduces walls and roof thickness and fulfills needs for extra insulators. Light grain density, density and heat transfer coefficient of light grain concrete are shown in table 1.

Table1. Light grain density, density and heat transfer coefficient of light grain concrete.

Thermal of insulator (w/m°C)	Specific gravity of concrete (kg/m³)	Specific gravity (kg/m³)	Light grains
0.19	400-450	30-120	expanded perlite
0.24	400-600	100-200	Expanded vermiculite
0.25	600-800	250-800	Expanded clay
0.35	1000-1200	600-1000	Pumice, scoria

**2-2 Using Perlite for Isolation:**

Expanded perlite is used for isolation of roof coating, building floors and pre-constructed walls. In roof coating, perlite concrete is good and resistant isolation and resists against firing. In addition, perlite concrete is used in flat roofs to adjust roof slope besides isolation. As perlite concrete is not solely sufficient to absorb humidity of roofs; therefore, it can be used by mixture of all tars.

**2-3 Using Perlite in coating mortar (whitewashing- stucco)**

In order to make perlite mortar about 25% of mixture weight, perlite light grain is used. Perlite coating has lower expansion coefficient than other coatings, this characteristic caused perlite to puff and crack less so protect carrier systems of cladding buildings from contacting fire. Perlite coating is lighter than similar coatings such as sand-cement coating and makes one isolator layer of noise and heat. Table (2) shows effect of using various proportions of perlite and plaster on specific gravity and heat transfer coefficient.

Table (2) properties of perlite plaster with various proportions of perlite and plaster.

Heat conductivity (Kal/mh°C)	Specific gravity	Perlite: plaster
0.23	0.94	1:1
0.16	0.70	2:6

**2-4- Tarry perlite:**

Tarry perlite can be used as coating on concrete. Tarry perlite can be used in renovation and impairment of old roofs and new sloping.

**2-5 Roofs with perlite concrete with non-structural application:**

One of lightening way of roofs is using perlite concrete. Perlite concrete has lower resistance than other types of concrete, but heat transfer reduces by increasing perlite and its thermal properties

improve. Heat conductivity coefficient, compressive resistance, and various concretes' densities are shown in table 3.

Table (3) - Compressive resistance, density and heat transfer coefficient in perlite concrete.

New concrete density (kg/m <sup>3</sup> )	Dry concrete density (kg/m <sup>3</sup> )	Heat transfer coefficient (Kal/mh°C)	Compressive resistance (mpa)
800	580	0.11-0.13	2.4-3.4
700	500	0.09-0.1	1.6-2.3
650	430	0.08-0.09	0.9-1.4
580	350	0.07-0.08	0.5-0.8

### 3- Conclusion

- Generally, the main reasons of using light grain perlite in building industry can be stated as following:
- By increase in perlite percentage and decrease in light grains in concrete in the same proportion, buffer-ability increase a lot, while compressive resistance of concrete decreases considerably. Therefore, as perlite increases buffer-ability considerably on one hand and reduces density on the other hand, it is suggested for lightening.
  - Plastering coating of perlite is implemented easily both for conformability and easy drying. Its resistance is so proper and its weight is less than plaster and sand mortar. These kinds of mortars are prior to other ones for being light and isolated against chill and warmth.
  - Using perlite as isolated material in building sector and other industries is relatively cheaper. In addition, using perlite as filler in weak concrete is cheaper than sand and gravel that adds specific properties of noise isolated.
  - Cases such as reducing structural and non-structural dimensions causing architecture space of building are so proper thermal and noise insulator, resistant against firing, pre-constructed pieces of light concrete and reduction of dead load on structure reasons of using light grain perlite in making light concrete.

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