



# Lightweight Concrete and its advantages compared with conventional concrete

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## Abstract

Concrete is one of the most widely used materials in the world. Considering the need to build high-rise structures, especially in building industry, it is better to reduce the dead load of buildings, structures lighter and also reduce the stress of. One of the best solutions for this purpose is using lightweight aggregate concrete in addition to make structures has another benefit too. In this paper we show that lightweight concrete especially at elevated concrete structures can be a great alternative to Ordinary concrete. Lead only to reduce the dead load of the concrete structure does not have but sound insulation and thermal and the ability to recycle and various other benefits are the advantages of this type of concrete. The use of concrete in construction increase the cost of materials but overall, economic savings will be greater in high-rise structures. The use of lightweight aggregate concrete not only in concrete but also has very efficient in building blocks. In this paper comparing the two types of concrete has been studied in two ways. First benefits of physical properties and second in terms of properties engineering including compressive strength tensile strength and modulus of elasticity been discussed and proven that the lightweight concrete has many advantages substitute for conventional concrete and old material.

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## 1. Introduction

Required extensive and increasing Community to building and housing and the application of new methods and materials in order to Increase the speed of building, light, resistant and also increase the

useful life of buildings against earthquakes Has raised more than before. Solve the problems of long-running, low useful life and the cost of operating the buildings Need some solutions to intended purpose to Practical use of modern methods and new building materials to reduce weight and construction time, more durable and ultimately reducing the cost of implementation.

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Reducing the Weight One of the topics in the science of modern style building that is growing day by day and Progress. This technology consists of lose weight buildings by using new techniques making materials and implementing new optimization techniques. Reducing the weight of the building in addition to saving money, time and energy, Losses arising Natural disasters such as earthquakes lowered and minimizes the damage caused by the weight of the building [1,2].

## 2. Background research

The first historical records about the use of concrete and lightweight aggregates can be traced to ancient Rome. Roman Pantheon and the construction of the stadium Klwzyvm of pumice that have used some sort of lightweight materials. Lightweight concrete application of artificial lightweight aggregate production and processing in the early twentieth century entered a new phase. In 1918 S.J.Hayde, Using a rotary furnace to expand the clay and shale, and thus artificial lightweight aggregates were produced, and the name of the lightweight aggregates to put Haydyt. During the 50's and 60's, many buildings and bridges were built with concrete in the world [3,4].

## 3. Overview and Definitions

Lightweight concrete is concrete that its specific gravity is much lower than normal weight aggregate private concrete that is made or broken. Light concrete is classified in three types:

### 3.1. Non-structural lightweight concrete

separators commonly known as blades and sound insulation foam used and has the specific weight less than  $800 \text{ kg/m}^3$ . Despite the low density, compressive strength of about 0.35 to 7 MPa.

### 3.2. structural lightweight concrete

Specific weight is sufficient in such a way that its application in structural members is permitted.

This concrete has a density of between 14 to  $\text{KN/m}^3$  and a minimum compressive strength of 17 MPa is required.

### 3.3. Medium lightweight concrete

In terms of density and compressive strength in the range of structural and non-structural concrete is placed. Between 7 and 17 MPa compressive strength of concrete and the specific gravity is 8 to  $14 \text{ KN/m}^3$ .

## 4. lightweight concrete components

Its components include sand, water, cement and additives following materials:

### 4.1. Shells:

Porous grains and style that is available in two types of mineralization and industrialization. Shells are marketed in various directions with respect to the grain size are known by the following:

- Size 0 to 3 mm cartridge sand to production style block.
- Cartridge size of 3 to 12 mm lens to production style block.
- Buff cartridge size of 5 to 16 mm for flooring and Slope.
- Almond cartridge size 10 to 30 mm Orientation to make the roof slope.

### 4.2. Pumices:

They are the lava that after reaching the ground surface coming cold and fine and coarse grains are porous as Scoria and pumice.



Fig 1. Pumices

#### 4.3. Types of types of shells

Mainly from heating and expansion clay with a temperature of about 1200 ° C in furnace revolving obtained as Lica and Perlit.



Fig 2. Lika

Suppliers of raw materials foam sponge is a matter of continuously combined with cement and water.

##### 4.3.1. Foam characteristics:

- *Liquid*: white color and density (specific gravity) 2 and PH: 3% ± 7.
- *Solubility in water*: Infinite.
- *Freezing point*: about 15 degrees below zero.

- *-Flammability*: Non-flammable.



Fig 3. Kefaferin

## 5. Compare the lightweight concrete and ordinary concrete

### 5.1. Running on lightweight concrete:

lightweight concrete at least three times faster than conventional concrete is done by increasing the height of flooring is also much more.

### 5.2. Long-term economic factor:

In comparison between lightweight concrete and normal concrete because of tiny bubbles, this product can be insulated pipes that are known from the palm rejection and there is no need to plumbing the pipes and so on.

### 5.3. The economic benefits of lightweight concrete:

This advantage is perhaps the main reason for the use of concrete.

*5.4. excellent properties against freezing and corrosion from it and resistance to moisture penetration, water and sound insulation:*

Lightweight Concrete has high porosity that is a very good result for sound insulation and even blow and percussion sounds alluring and in the thermal insulation of lightweight 10 cm concrete acts as 30 cm Pumice.

*5.5. Extraordinary properties against heat, cold and sound:*

Lightweight concrete has a high resistant against fire. For example, a piece of lightweight concrete weighing space 250 to 300 KG/m<sup>3</sup> at least 8 inches thick to be easily withstand 1270 c and is incombustible in each density.

*5.6. compressive strength:*

This parameter in lightweight concrete is almost like regular concrete, in 28 days reaches of its main strength and then as a function is linear in the range of 12 months.

*5.7. Thermal resistance:*

Due to the porous nature, this type of concrete is an excellent thermal insulation that will dramatically increase with decreasing the density of concrete.

*5.8. Comparison of weight with shells:*

In the case of flooring and slope taking place in buildings that mainly used shell casings and cement if the replacement of this type of concrete with a density of 300, flooring dead weight of 1300 reduced to 300. This means reducing 1000 kg/m<sup>3</sup> the weight of the building.

*5.9. Saving*

When using the construction and operation Due to good thermal insulation lightweight concrete, significant savings can be achieved in energy

expenditure and caused a significant reduction in resource consumption.

**6. the Benefits blocks made of lightweight concrete:**

*6.1. Thermal insulation:*

Insulation and shape of hollow blocks, causes Wall made with the approval of the building's exterior walls is optimized for use in fuel and also meet the technical requirements. Energy savings while maintaining the internal temperature and Impenetrability Heating and cooling of the outer wall of the building, among the features of the index is lightweight concrete blocks if applying Lica mortar to prepare, this rate increases to 10 percent.

*6.2. Sound insulation:*

Reduce noise from outside the building, between units and rooms adjacent buildings is one of the requirements. Double and triple glazing for sound insulation of lightweight blocks and also used in the manufacture of as well as on the concrete floor, causing a sharp rise in the volume drop. For this purpose, special-purpose buildings such as hospitals, Schools, universities, cinemas and so on, the use of lightweight blocks and insulated with double-glazed windows and a concrete floor and the slope is recommended.

*6.3. Fire proof:*

Non-flammable and fire-resistant materials, is very important. Thermal shock in the wall due to High temperature difference between the two sides of the wall, a lot of damage to buildings has arrived and the transfer of fire to other parts of the building. Lika blocks, given that its shells produced at a temperature of 1100 degrees and suddenly getting cold, can resist against fire for 3 hours.

#### 6.4. Physical workability:

Cutting walls made of lightweight concrete for crossing facility is Very convenient. The tool grinding, gouging, drilling, installing cabinets and heavy equipment on the wall are other features of this product Considered.

#### 6.5. Resistance:

Due to the use of mortar walls on four sides of each block in Chinese and the shape of the concrete structure by mortar and high compressive strength on the block is the Cause of to eliminate the self coefficient of the block. This property is in this type of wall only. So never saw the cracked in plaster or cement wall will not be built with lightweight concrete.

#### 6.6. good water absorption:

Low water absorption of the blocks, is the cause of reduces the speed of implementation and stonework and high water absorption causes plaster or cement plastering clamping block and therefore it will be scaling. and the stonework and wall tiling, the mortar behind the stone and Ceramic due to Rapid absorption of mortar water by blocks, the cement mortar Burnt and the setting in stone mortar is reduced. Blocks made of lightweight concrete due to its cement base, has an appropriate water absorption and homogeneous mixing it with the stability and better adhesion between the stone and the wall blocks.

#### 6.7. reduces the cost of the finished wall:

lika walls in openings 5 to 6 meters depending on the thickness of the wall, are implemented. Because of suitable porous block level, for plastering without the use of plaster and with low thickness can be taken. and there is no need of buffer to increase the adhesion of mortar and plaster wall. The Cost walls of the blocks are lower than other building materials.

#### 6.8. Comparison between consumer interests:

Comparisons among Materials used are shown in the following table.

Table 1. Compares the materials between conventional and lightweight concrete

Ordinary concrete	lightweight concrete	materials type
Type 1	Type 2	Portland cement
Sand and gravel	Sand	Fine-grained
Aggregate buff	lika	Coarse-grained
water	water	water
Not commonly used	Carboxylate	Lubricant

Table 2. Comparison of specific weight kg/m<sup>3</sup>

ordinary concrete	lightweight concrete	Type of concrete
Between 2200 to 2500	Between 300 to 600	Specific weight

As is clear from the table, the main difference between Materials is the use of Lightweight seeds and Lubricant in the lightweight concrete. The use of super plasticizer on the concrete is very low and the main reason for its use of Lightweight and water absorption by seeds and require proper lubrication to maintain performance concrete. The use of alternative grain Lightweight coarse and fine-grained concrete part of the concrete is the most important factor for lose weight.

#### 6.9. Compare specific weight:

The most important and most obvious difference between these two concrete is their weight. So that as shown in Table 2, the difference in specific weight is between 600 and 800 kg of concrete. This difference in construction of buildings over four stories will be numerous and decreasing the weight can be saved in rebar consumption and the columns and the beam diameter is reduced. In addition to these factors, the depth of the foundation and its weight is reduced which has been discussed in the economy.

Table 3. Comparison of compressive strength of lightweight and heavy concrete

90 days wet Maintenance	90 days dry Maintenance	7 days wet Maintenance	7 days dry Maintenance	type of concrete
43	28	25	15	Ordinary concrete
39	37	32	30	lightweight concrete
43	41	28	25	lightweight concrete whit slag

Table 4- compares the tensile strength of 28 days

conventional concrete	lightweight concrete	
1.7	3.2	tensile strength Without slag
1.8	3.8	tensile strength With slag

#### 6.10. Compare compressive strength:

Unlike the imagination and a series of lightweight concrete results from tests Without the use of conventional Slags, shown good and acceptable results. In table 3, Resistance slag combined with 10% Microsilica and 10 percent of Metakaolin and without the use of slag compared with conventional concrete.

the task of bearing structures stretch and as shown in Table 4 Tensile strength obtained for conventional concrete indicate a low level of importance the tensile strength for this type of concrete but in lightweight concrete the tensile strength is obtained up to 2 times of conventional concrete.

According to Table 3:

- obtained resistance in of lightweight concrete without slag is very close to normal concrete and If this resistance with high specific weight difference between the two types of concrete used The lead of lightweight concrete is fully approved.
- Unlike conventional concrete of lightweight concrete according to Table 3 in the dry state and wet, the difference is striking and changed little resistance mainly due to Maintenance an amount of water in the pores Lightweight Lika aggregate and water to the reaction of cement and thus reduce the resistance will be low. And as is specified in Table 3, with addition of slag cement replacement percentage, higher strengths can be achieved for of lightweight concrete. For higher strengths, fiber and other methods can be used.

#### 6.11. compared to the tensile strength:

Another remarkable point for lightweight concrete is better tensile strength than conventional concrete. Fittings are charged with

#### 6.12. Compared modulus of elasticity:

In the comparable lightweight concrete results in the near and convenient. According to Table 5 the results show good resistance of lightweight concrete compared with conventional concrete.

Table 5. Compare the modulus of elasticity in terms of Gpa

conventional concrete	lightweight concrete	
19	17	tensile strength Without slag
1.8	17.71	tensile strength With slag

## 7. Economy Survey

### 7.1. Economic evaluation of the use of lightweight concrete in building:

Materials Selection and construction procedures require detailed knowledge of means and ends of work. Modern methods selection, advanced machinery and more delicate Materials, does not Means of more economic, technical and fit but a series of affecting factors such as the social, cultural and economical, are determine the identified outcome of a procedure or technology.

### 7.2. Reduces the cost of load-bearing structures:

Using lightweight concrete reduces dead load of the building whit 20 to 30 percent of the total. If the weight loss seen before from the design stage, bearing optimum weight will be reduced. Also, if the design and implementation stage Lika products used, Increase confidence building steps implemented to cover the possible defects.

### 7.3. Reduce the cost of energy:

Use lightweight concrete helps to reduce energy consumption for heating and cooling the building which leads to considerable savings in costs paid.

### 7.4. Reduce the costs of installations:

Insulation lightweight concrete facility makes the devices to achieve optimum heating and cooling capacity and will buy at lower prices. It also reduces the cost of energy in the future are building.

### 7.5. Reduce maintenance costs of the building:

Because of the durability of lightweight concrete and other building components having harmful effects on installations, especially their role in reducing the cost of building Maintenance. In addition, it is possible to carry out repairs if needed due to high workability, dismantling of building components is very limited.

#### 7.6. Reduce the space occupied:

Chinese wall blocks remote areas of the building will be reduced. If you use other methods, the Chinese wall (Such as 2 glazed walls), building shelf space runs low.

#### 7.7. Speed in implementation of the work:

According to fit different sizes and shapes and made of lightweight concrete blocks, higher speed implementation of the work and capital allocation efficiency in the building sector is earlier. Based on the results obtained, in comparison the beams made of lightweight concrete with conventional concrete, the amount of steel about 21 percent decline, but because of the requirements of ductility in the columns the amount of steel will be equal. The other hand the speed of implementation is faster. And also due to lower weight structures built with lightweight concrete, foundation size is smaller and cost less.

### 8. Conclusion

Today, new Materials, existing many opportunities and challenges for civil engineering. Proper use of new Materials can exist many benefits both in terms of time, in terms of structural and in terms of cost. Using concrete reasons that were discussed, will be is very effective. although the initial cost is more than conventional concrete, but with multiple benefits such as Insulation, increase speed, reduce dead space of the building, reducing maintenance costs and another advantages mentioned, its use in construction projects is suggested.

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