Principles and methods of building construction(volume 3)

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Dedicated to my father

A steadfast mountain and supporter of me throughout my life

Dedicated to my mother

The stone of patience that taught me the alphabet of life

Dedicated to my brothers

Kind companions of my life.

Introduction:

For a long time, shelter has played a vital and decisive role in human life and settlement. Due to the extraordinary progress of man in all sciences, the construction industry is no exception to this rule. In order to have strong and safe structures to protect the lives and property of residents, it must be accompanied by up-to-date knowledge to prevent accidents in buildings. Special attention to the principles and methods of building construction from demolition to joinery are basic and very important issues in the construction industry that in this book (Volume 3) I have tried to mention as much as possible, which are:

Concrete, its properties and applications, types of concrete additives and their applications, types of concrete tests and experiments, methods of reducing concrete damage to the environment, sealing methods and underwater concreting methods. I hope to take a very small step in the development

of the construction industry by writing this book.

With respect

Mohammad Tayyebi

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Chapter 4

Concrete and its applications

What is concrete and what is its use?

This material is generally the result of the interaction of hydraulic cements and water. Even today, such a definition of concrete includes a wide range of products. Concrete can be made from different types of cement as well as pozzolans, kiln slag, sulfur, concrete additives, concrete polymers, concrete fibers, etc.

Due to the development and advancement of science and the emergence of many technologies in the last century, the knowledge of concrete and its properties has also developed significantly, so that today we see the use of different types of concrete with different materials, each of which has its own properties and uses. Currently, different types of cements are produced, including pozzolans, sulfurs, polymers, different fibers and different additives. It can also be noted that the production of concrete is done using heat, steam, autoclave, hydraulic vibration pressure and mold.

Concrete is generally a product that is obtained by mixing water with aqueous cement and various aggregates due to the reaction of water with cement in certain environmental conditions and has special properties. The availability of its materials, relatively high durability and the need

for numerous constructions of concrete structures such as buildings, structures, dams, bridges, tunnels and roads, has made this material very popular. For about three to four decades now, the use of this substance in special circumstances has been welcomed by its users. Today, with the advancement of science and technology, it has become clear that simply considering the strength as a criterion for the design of dry concrete for different environments and different applications can not answer the problems that arise in the long run in concrete structures.

For several years now, the issue of concrete durability in various environments has been considered. The observation of failures with physical and chemical factors in concretes in most parts of the world and with more intensity in developing countries, has led thoughts and minds to design concretes with special characteristics and durability. In this regard, in some countries, guidelines and standards have been prepared for high-performance concrete design, and designers and implementers in some of these developed countries have been required to comply with these guidelines.

Concrete ingredients

1.Cement

Cement mortar is a constituent of concrete.

2. Water

Water quality in concrete is important because the impurities in it may affect the hardening of cement may also adversely affect the strength of the concrete, causing stains on the concrete surface and even rusting of the bar. In most mixtures, the water suitable for concrete is the same as the water suitable for drinking. The solids of such water will rarely be more than 2,000 parts per million ppm, and typically less than 1,000 ppm. This value is equal to 0.05 weight of cement per water to cement ratio. The criterion for the suitability of drinking water is not for absolute mixing, and a drinking water may not be suitable for concreting due to its high percentage of sodium and potassium ions, which carry the risk of an alkaline reaction of rock aggregates. As a general rule, any water that has a pH (acidity) between 6 and 8 and does not taste salty can be used for concrete. Dark colors and odors do not necessarily prove the presence of harmful substances in water.

The amount of water used in cement

The amount of water consumed inside the concrete is very important. In order to complete the process of reaction of cement with water, a certain amount of water is required. If this amount is less than that limit, part of the cement will not receive enough water to react and will remain unreacted. If more than the required amount of water is added to the concrete mix, after completing the reaction, some water remains freely inside the concrete, which after hardening of the concrete will cause it to become hollow and consequently reduce the strength. For this reason, care should be taken not to consume too much water inside the concrete in order to achieve high strength.

The amount of water required to complete the reaction is defined as a parameter of the ratio of water to cement. This ratio is about 25% for ordinary Portland cement. With this amount of water, concrete will not have the necessary efficiency and usually the ratio of water to cement used in construction workshops is more than this amount. In determining the mixing ratio of concrete, a parameter is considered that also considers the amount of moisture in the aggregates before adding water to the concrete, which is important in determining the amount of water

required. This excess moisture is the amount of excess moisture in the aggregates from the saturated state of the SSD (Saturated Surface Dry).

3.(Aggregates): Aggregates in concrete make up about three-quarters of its volume, so their quality is of particular importance. In fact, their physical, thermal and sometimes chemical properties affect the performance of concrete. Natural rock grains are usually formed by weathering and erosion or artificially by crushing mother rocks.

Size of stone aggregates: Concrete is generally made of aggregates of different sizes with a maximum diameter of 10 mm and 50 mm. On average, aggregates with a diameter of 20 mm are used. Particle size distribution is commonly known as "aggregate granulation". In general, grains with a diameter of more than four or five millimeters are called grit and smaller ones are called sand, which is determined by a 4.75 mm sieve or a score of four. The lower limit of sand is usually 0.07 mm or slightly less. Materials with a diameter between 0.06 mm and 0.02 mm are called silet and finer materials are called clay. Mud is a soft substance that contains relatively equal amounts of sand, silet and clay.

4.Important minerals: Important and common minerals of aggregates in the field of use in concrete are: Siliceous minerals (quartz, opal, calcine, trimeite, cristobalite), feldespat, mica minerals, carbonate minerals, sulfate minerals, Iron sulfide minerals, ferromanganese minerals, iron oxide minerals, zeolites and clay minerals.

In the ASTM standard, stones are divided into five groups in terms of appearance: perfectly rounded, rounded, relatively rounded, relatively sharp, and sharply angled. In the BS standard, this designation is rounded, amorphous and irregular, flaky, sharp, long flaky.

✔ Concrete curing

With continued Hydration, the strength of concrete increases and this reaction causes the increase of strength of concrete or the hardening of cement. Relative humidity must be at least 80% to process or continue the hydration process. If the humidity is less than this amount, concrete processing will stop and if the relative humidity returns above 80%, the hydration process will start again. Due to the evaporation of some of the required water before the completion of the reaction between water and cement (which takes

several days), part of the cement in the concrete mix remains unreacted. Immediately after concreting, the necessary attention should be paid to the curing process.

Curing is the retention of moisture in concrete until the reaction between cement and water is complete. This can be done by temporarily insulating, spraying water or producing steam. From a practical point of view, it is recommended to keep the concrete moist for 7 days. In cases where this is not possible, the minimum concrete curing time should not be less than 2 days.

Types of concrete

Building concrete is divided into the following types according to its type of use:

Ordinary concrete

The most common type of concrete is mixed and consists of Portland cement, sand, gravel and water. This concrete is used with or without bar in structures, roads and foundations. The mixture ratio of sand, cement and cement of this concrete varies from 1: 1: 2 (for the strongest mixture) to 1: 3: 6 (concrete megr or as bed concrete). This concrete is made with typical aggregates and

cements of Portland type one to five and has a specific weight of 2200 to 2500 kg / m3.

Voluminous simple concrete

simple concrete is called concrete without bar. This concrete is used in voluminous concreting such as dam foundation , retaining wall, etc.

megr Concrete

Concrete is also known by other names such as cleaning concrete or reglage concrete and its most important feature is its low cement grade. This means that the amount of cement used in it is much less than the structural concrete. Concrete megr is in fact a concrete with a low amount of cement (100 to 150 kg of cement per cubic meter) and is used to prepare the excavated bed for rebar binding .

Why is concrete megr used?

Concrete megr is used for two reasons:

1. To prevent direct contact of the main concrete of the foundation with the soil,

2. To regulate the foundation floor and create a smooth surface to continue the foundation.

Advantages of concrete megr:

- Prevent the penetration of cement into the soil
- Prevent the absorption of concrete water by the soil
- Preparing the soil bed for foundation
- Smoothing, aligning and homogenizing the foundation
- If excavation is done too much, it is used to level the foundation floor.
- Fill in the blanks

Principles of concreting megr

To pour this concrete, after preparing the foundation floor, it is necessary to wet the concreting bed so that the concrete water does not leave the floor under the foundation quickly. Of

course, care must be taken so that water does not collect on the floor and there is only moisture.

After the foundation floor is wet, the prepared concrete should be poured in the range of foundation dimensions plus 5 to 10 cm on each side of the area. The poured concrete must be completely compacted and its upper surface must be completely leveled using a leveling hose and the trowel must be flat and uniform.

After concreting, concrete curing is done. When pouring concrete, make sure that the height of the concrete is not less than 5 cm at any point.

Instructions and execution of concrete megr

It is necessary to apply a layer of concrete megr under all reinforced concrete foundations that have bar in the vicinity of the bottom surface. Concrete megr reduces the risk of contamination of structural concrete during concreting operations. Creating a gap between the natural ground and the foundation prevents the ground water from absorbing the concrete of the foundation.

Necessary hints when applying concrete megr

1.Lime concrete should be wet before applying concrete so that it does not absorb concrete water.

2. Concrete megr should be applied on the lime concrete when the lime concrete strength has reached 1.5 kg / cm2.

3. The lime concrete has reached a resistance of 1.5 kg per square meter when the effect of the shoe does not remain on it after walking.

4. Concrete megr is usually made by small concrete mixers.

5. Make sure that the concrete inside the machine is well mixed for at least two minutes after adding water and then used.

6. After pouring the concrete megr, depending on the air temperature, the surface should be kept moist for about 10 hours. Then, after one day, the next operation can be started.

Structural concrete

Structural concrete is concrete that can be used for load-bearing members of a structure. The weight of this concrete while compacted is about 2400 kg / m3 and should have high strength. If this concrete is made of lightweight stone materials, it

can have high strength by observing special criteria in its design.

Reinforced concrete

It is called concrete that is reinforced with rebar. Reinforcing rebars, reinforcing mesh, metal plates or reinforcing fibers are used to reinforce the concrete. The main purpose of using reinforced concrete is to transfer the tensile forces created in the concrete to the rebars (due to the high tensile strength of the rebar), and In this way, tensile forces do not enter the concrete and do not cause cracking of the concrete.

Situ concrete

It is concrete that is poured and hardened at the place of its permanent use. This method is the most common method of execution in concrete structures.

Precast concrete

It is concrete that is poured in separate molds in the concrete factory and is done in a controlled way and hardens and is transported to the workshop site when necessary for final

installation. In this process, concrete can be made with high quality formwork and strength and relatively low price. This method is used to produce floor slabs, blocks, road construction tables, fence railings, beams and walls. Prefabricated parts can have bar and engineering steel parts can be embedded and installed in it.

Vacuum concrete

It is concrete that has a high percentage of water to provide the necessary performance and concrete can be poured in complex molds or around compact rebar binding. The concrete is then vacuumed and most of the water is removed, thus giving the concrete more strength when it hardens.

Pump concrete

Pump concrete is concrete that is transferred from the mixer to the discharge point by a pipe. The concrete is discharged from the mixer into a funnel and from there enters the pump, which, by applying force to it, causes the concrete to move forward in the pipe. The diameter of the pipe is 150-100 mm and with this method, the concrete can be pumped up to a horizontal distance of about 650 m or a vertical distance of about 50 m or a combination of these two sizes. Pumped

concrete should have a higher water content to improve the fluidity of the concrete. If high strength concrete is required, special additives should be used instead of excess water.

Stressed concrete

This method is used in the production of concrete pipes. The production process involves pouring relatively dry concrete into a rotating cylindrical mold. The concrete is poured into the mold wall by centrifugation, creating a dense, impermeable hard wall.

concrete ready

It is concrete that is made in a concrete factory and transported to the workshop by a mixer truck. In this transfer, the cylindrical source in which the fresh concrete is poured is rotating continuously from the time of loading to unloading the concrete. The specifications of the concrete mix are agreed between the manufacturer and the consumer before construction and are usually of high quality.

Water resistant concrete

Water-resistant concrete can be waterproof or sealant.

- Waterproof concrete consists of a surface with a water resistant layer while the internal volume of concrete is ordinary concrete. The waterproof layer can be created by applying a spray of varnish or by applying a layer of bitumen or asphalt on the concrete surface or by applying a solution of sodium carbonate (baking soda) or sodium silicate.
- Sealed concrete can be produced by making dense concrete with strict quality control to prevent water or air from entering. Concrete made in this way will be sufficiently sealed and can be used for water tanks.

Very dense concrete

Highly compact concrete is used in the construction of protective walls of nuclear power plants and balance weights and offshore walls using different stone materials. Consumables include barites (barium sulfate), hemtite (iron oxide crystals), iron pellets, and lead and steel pellets.

This composite compound has good integrity and cohesion and allows the use of concrete as a formable material to produce resistant curved surfaces. Fiber concrete also has a high amount of

energy absorption and does not disintegrate easily under impact loads. Extremely high compressive strength is achieved by FRC, using suitable granulation that is homogeneously mixed. Today, fibrous concrete with the use of glass fibers, polypropylene, steel and some carbon, its production and use in various industrial applications in the developed world is possible.

What factors determine the quality of the fibers used in concrete?

•Concrete mix ratios

• Geometric characteristics of steel fibers

• ratio of length to diameter of the fibers

• Mechanical restraint and surface roughness of the fibers

• Physical characteristics and fiber material

What are the types of fibers used in fiber concrete?

Steel fibers:

It is made of a combination of ordinary concrete with steel fibers in a flat, twisted, wavy, hook-like and edged shape, which often have a diameter of 0.25 to 0.76 mm. Steel fibers are widely used in concrete and reinforced concrete structures to improve the properties of concrete. The use of steel concrete fibers increases the strength of concrete structures, thus increasing the efficiency.

Polypropylene fibers:

The combination of polypropylene with concrete is used to strengthen the cement-gypsum mixture

and flatten the concrete. Polypropylene fibers have a high resistance to shear and abrasion. This type of fiber is hydrophobic and its adsorption percentage is zero, so there is no need to add extra water to increase the flow of concrete. Polypropylene fibers are fire resistant.

Glass fibers:

Fiberglass concrete is usually obtained by combining concrete with fiberglass-shaped filaments of heated glass. Very thin strands of glass are produced in fixed diameters and indefinite lengths and are usually between 5 and 25 microns in diameter. Glass fibers increase the tensile strength of the concrete structure, as well as provide thermal, moisture and sound insulation.

This type of fiber greatly reduces the efficiency and slump of fresh concrete, so suitable lubricants should be used to solve this problem.

Carbon fiber:

The most important advantages of carbon fiber are high fatigue strength, corrosion resistance and low expansion coefficient.

Synthetic fibers:

Kolar, nylon and polyester are among the synthetic fibers that can be combined with concrete and are usually available in diameters of 0.02 to 0.38 mm. Synthetic fibers have a high melting point, so they are very resistant to heat.

The properties of synthetic fibers include lightness, strength and corrosion resistance.

Aramid fibers:

Aramid fibers come in many forms and, like glass and carbon fibers, can be used to make composites. Aramid polymers have properties such as high melting point, lightness and low weight, high thermal stability, high tensile strength and flame resistance. This type of fiber has different shapes and flame resistance and insolubility in many organic solvents are their prominent features.

Where is fiber concrete used?

Fiber reinforced concrete has various applications.

Types of concrete fibers are used in the construction of concrete bridges, airports, military structures, road construction and paving of sidewalks, construction of concrete dams, tunnels, power plants, refineries, water tanks, retaining walls, foundations, construction of industrial sheds and industrial flooring, warehouses Storage of medicines and food, floors of multi-storey car parks, construction of prefabricated building parts.

What are the advantages of fiber concrete?

The flexibility of fibrous concrete, like the properties of plastic materials, means that fibrous concrete does not have sudden rupture. Because the fibers in the concrete body are scattered in all

directions, if a crack is formed in different directions, the fibers will form joints and prevent the crack from spreading. Therefore, fibers are actively involved in limiting the width of cracks and increase the usability of concrete by forming many fine cracks.

Fiber concrete has superior mechanical properties such as compressive strength of more than 150 MPa, high modulus of elasticity, high elastic limit, tensile stiffness, fracture energy several times the amount of traditional concrete and high capacity after cracking. The following is a list of some of the other benefits of fiber concrete:

- Increase in energy absorption
- High resistance to abrasion
- High relative deformation capacity
- Excellent impact resistance

How do fibers work in concrete?

The fibers enclose the aggregates and prevent the coarse aggregates from separating due to vibration and gravity, ensuring better cohesion. As a result, a uniform mixture of concrete and fibers is produced, which slowly transfers water to the surface during setting, resulting in fewer cracks in the concrete.

How to use fibers in concrete and how much it consumes?

The fibers can be added to the mixer at any time. The fibers can also be added to the mixing water at the end and poured into the mixer, in which case the stirring must be continued for another 3 to 4 minutes to achieve a uniform mixture. If you want to use ready-mixed concrete, you can gradually pour the fibers into the mixer truck, and the stirring at high speeds should continue until you are sure that the fibers are completely spread inside the concrete. The amount of fiber consumption will vary from 0.6 to 3 kg / m3 depending on the desired performance.

Improving the mechanical properties of concrete using fiber concrete

Using 4% of fibers, the flexural strength of concrete is increased by 2.5 times. Concrete containing fibrous materials has a resistance to breakage due to stress, about 10 to 40 times compared to plain concrete. The impact strength of fibrous concrete is generally 5 to 10 times higher than plain concrete, which varies depending on the amount of fibers used in different concretes.

Is the use of fiber concrete economically justified?

The use of fiber concrete in all cases is not more economical than traditional concrete. But according to estimates made by some experts in the country, in places where high execution speed is considered or the need to spray concrete (shotcrete) on surfaces where traditional networking has been difficult and time consuming, the cost of using fiber concrete is less than traditional concrete.

But if we avoid adopting new technology because of the risk involved in investing, we will see that traditional technology will waste a very large amount of our capital in the absence of new technology. For example, fine particles produced in the old non-standard methods increase the percentage of cement used in the building, which causes cracks and wastes in the resulting concrete.

High quality concrete (high strength concrete)

The ACI standard defines high-strength concrete as concrete with a compressive strength greater than 400 kg / cm2. Today, by using high technology in making quality concrete, the compressive strength of concrete has reached

1300 kg / cm2. For the production of high quality concrete, optimization of the main components of concrete is very important. For this purpose, in addition to selecting high quality Portland cement, the ratio of water to cement is changed and the ratio of mixed stone materials to cement is optimized.

Pozzolans, such as fly ash and silica fume, are the most common mineral additives used in high quality concrete. In addition, it is difficult to produce high quality concrete without the use of chemical additives. For this purpose, super lubricant are usually used in combination with retarders and water reducing agents in concrete mix. High concrete applications are in high-rise buildings that require a reduction in the weight of the structure or architectural constraints require the designer to use small structural members. An example of such a structure is the 295 m high Chicago Building, which is made of concrete with a compressive strength of 800 kg / cm2 and is the tallest concrete building in the United States.

What are the benefits of using Concrete foam?

Concrete foam or lightweight concrete or spongy concrete as materials whose density is significantly lower than ordinary concrete and can

play an effective role in reducing the weight of buildings, especially in other structural parts.

Concrete foam is a light and durable coating that is used for various applications in the construction industry. It is made from a combination of cement, soft sand, water and foam (a chemical that produces foam). This mixture creates a lightweight porous material that has high strength and durability. Concrete with a foam material based on animal protein is called Concrete foamed.

The lightness of this concrete in reinforcement of concrete and building structures reduces the dead load of the building, saves the volume of excavation and concrete used in foundations, as well as reduces earthquake loads. To increase the efficiency of this product in various projects, the amount of mixing and additives required is adjusted and prepared according to the experiences and standards of Germany, Britain and the United States, and resistance tests are performed on them for the final production.

Today, in most construction projects, light and durable materials are used as much as possible. Materials that do not put extra weight on the building and increase its strength and longevity.

For this purpose, you can use materials that do not take much time to work with. Concrete foam is one of the materials that can be easily used and take advantage of its insulation.

Durability and strength of concrete foam

The strength and durability of concrete foam depends on its components. For example, concrete foam made of sand is higher in strength and density than Concrete foam made of foam and concrete.

One of the materials used in foam concrete mixtures is Portland cement, which mixes with cement and foam on its own. In addition, the mixture may be composed of limestone. These mixtures create ideal products for construction projects, and the higher their density, the higher their resistance.

Advantages of using concrete foam

1. Concrete foam is highly resistant to water penetration, frost and erosion. concrete foam has a lot of porosity and creates small cracks in the surface. If this material is used with sufficient thickness, its resistance will be very high.

2. This foam is very light weight and reduces the weight of the roof and the structure of the building and reduces the costs related to the foundation of the building. In addition, the light weight of concrete foam reduces the damage caused by earthquakes.

3. Concrete foam is a kind of insulation against heat and cold. The use of this insulation reduces the costs associated with energy consumption in the building and reduces the use of heating and cooling devices. In addition, due to sound absorption, it is a kind of sound insulation that prevents additional sound from entering the building. This foam has a high fire resistance and is non-combustible.

Application of concrete foam

The main applications of lightweight concrete that we see today in Iran include lightweight roof and wall blocks, as well as flooring and land grading. One of the most important and widespread applications of concrete foam is flooring of building floors.

Execution of concrete foam is done using concrete foam machine with high speed and after finishing the installation works, the floor of all

floors of the building can be covered with it. Instead of scoria on the floor, the use of concrete foam compounds lightens the floor and provides thermal and acoustic insulation of the floor.

Another use of concrete foam is to build integrated walls in a variety of halls, cold stores and…. By molding at the project site, concrete can be poured seamlessly and vertically, or with a series of special molds, prefabricated panels can be produced. Due to the insulating properties of this foam, it is used in the insulation of thermal and refrigeration pipes, walls, acoustic rooms and motorhomes.

The high strength of concrete foam and its impermeability and light weight make it used for sloping roofs. This material reduces the dead load of the building and reduces the force applied to it by the earthquake. The roof can be insulated with this material.

In addition to the above, concrete foam is also used to fill potholes in the streets and pave roads. This material is liquid and is used as a filler.

In addition to the above, concrete foam to fill the holes created in the streets and roads infrastructure

can also be used. This material is liquid and is used as a filler.

Concrete foam ingredients

In the production of these concretes, mainly pumice and low density industrial or mineral materials are used as aggregates or light fillers. In addition to concrete with light aggregates, the products of some factories are also in the form of blocks and panels of light concrete based on sponge concrete. The advantages of this type of concrete, besides being light, high thermal insulation and the possibility of cutting with a saw, the possibility of grooving and using nails and screws. This type of concrete is divided into two types depending on the method of producing air bubbles:

1.Light gaseous concrete(AAC)

Autoclaved aerated concrete (AAC), which is called AAC in the world for short, is a special type of lightweight porous concrete that is mainly made of silica, cement and lime based materials. The product, now known as the AAC, has been developed in Sweden for the last 70 years. This product includes two main processes of creating porosity in the slurry of a mixture of cement, lime

and silica powder and processing the resulting concrete by autoclave.

Among the advantages of this type of blocks, the following can be mentioned: Observance of Articles 3, 18 and 19 of the National Building Regulations and high speed of execution due to suitable dimensions, building style according to Iranian 2800 regulations, very good adhesion Between the block and the cement mortar due to its homogeneity, no need to coat more than one centimeter due to the smooth surface of the block, reduction of costs related to joinery due to the smooth surfaces under work with the implementation of this block, high speed porcelain wall, and all Most importantly, significant savings in steel consumption in steel and concrete structures, which reduces the dead load of the building.

The connection of non-load-bearing walls to the structural frame must be such that while bearing all the loads, it does not cause lateral stiffness of the structure. Walls made with this block must have the necessary resistance to impact tests according to the criteria of the National Standard of Iran No. 11272, and it is mandatory to observe the rules related to protecting the walls from direct

contact with water or wet and drying cycles. All materials and components in this system in terms of durability, health and environment must be used in accordance with the national building regulations of Iran or national or valid international regulations.

In the production of gaseous concrete, soft aluminum powder is added to the mixture under certain conditions to produce bubbles of hydrogen inside the concrete due to chemical reaction with calcium hydroxide. The release of these bubbles causes the mixture to expand.

2. Foam concrete

Lightweight foam concrete, also called cellular concrete, is a type of lightweight concrete. But in the production of foam concrete, unlike gaseous concrete, air bubbles are produced with the help of a foaming agent and are added to the concrete mix.

Insole concrete production technology is simpler than gaseous concrete production technology, and it is also possible to make this type of concrete in construction workshops. The basic materials in making foam concrete are cement, water and foam made from a foaming material.

A material called foam is usually used to produce foam. The material is first diluted with water and then in a chamber by means of pressure caused by air compression or by rapid agitation, it becomes a foam in which bubbles with a diameter of millimeters and less are produced. To produce a stable insole in the internal structure of the foaming agent or independently a foam stabilizing material is used to stabilize the bubbles produced. The stabilization of bubbles means that the bubbles retain their shape due to displacement and mixing. The resulting stable foam is usually creamy.

Foam foaming materials can be structurally classified into two classes, which include animal protein-based materials and chemical foam foaming materials. Usually, the foam produced from protein-based materials is less volumetric and more stable than the foam produced from chemicals (in chemicals with a specific gravity of about 40 grams per liter with a foam stability of less than 2 hours and increasing the resulting volume Foaming is about 25 times the original volume.

Experience shows that chemicals are suitable for making concretes with a density of over 1000,

while protein materials can be used in the manufacture of concrete from a density of 500 to 1600 kg / m3. It should be noted that the stability of the foam should be such that after the process of mixing the foam with cement mortar, the foam retains its stability. Otherwise, the structure created by the placement and distribution of bubbles inside the mixture due to the loss of part of the bubbles before the initial hardening of the cement, disintegrates and as a result the weight increases. Due to the porous nature of concrete, this type of concrete is a very suitable thermal and acoustic insulation. In terms of sound, it is a good insulation for sound with a high coefficient of acoustic absorption, which has recently been considered by designers as a welfare factor to prevent the entry of additional sounds.

heavy concrete

According to the definition of ACI, heavy concrete is concrete that basically has a higher specific gravity than ordinary concrete. In the manufacture of heavy concrete, instead of sand, crumbs of steel, cast iron or barium sulfate are used. The specific gravity of heavy concrete is about 1.5 to 2.5 times the specific gravity of ordinary concrete. Heavy concrete can have a

specific gravity of more than 6400 kg / m3 based on the type and size of aggregate used and the method of compaction and discharge. If the specific gravity of ordinary concrete is about 2400 and heavy concrete is 6400 kg / m3, 40% of the nominal capacity of the mixer should be used to prepare a homogeneous and uniform mixture without adding additional pressure on the mechanical equipment.

As the density of concrete increases, many properties of concrete will increase or change. One of the most important properties is the abrasion resistance of concrete. Heavy concrete always has a higher construction cost than ordinary concrete.

Application of heavy concrete

Heavy concrete is especially used as a shield against radiation. The choice of concrete for radiation protection depends on the type and intensity of radiation and the requirements of the space. The performance of concrete protection against radiation is approximately proportional to the specific gravity of concrete.

The higher the specific gravity, the more effective the protection. Some aggregates are composed of

crystalline water called bond water, which forms part of their structure. For this reason, if the reduction of gamma rays and neutron radiation are both necessary, heavy aggregates with high crystalline water content are often used. To reduce neutron radiation, bor glass is added to heavy concrete compounds.

This type of concrete is also used in the construction of balancing weights and in cases where there is a need to increase the dead load of the structure without increasing the volume. Although the extraction, transport, breaking and granulation of aggregates to produce heavy concrete is expensive and mixing, transporting and pouring it is more expensive than ordinary concrete. Heavy concrete is also used in places that require high abrasion resistance