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АНГЛИЙСКИЙ ЯЗЫК

Сборник текстов
для студентов 1-2 курсов строительных специальностей

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Для студентов 1-2 курсов строительных специальностей.

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SECTION I

Text 1

CIVIL ENGINEERING

The word "engineering" means the art of designing, constructing or using engines. But this word is now applied in a more extended sense. Engineering is divided into many branches. The most important of them are: civil, electrical, nuclear, mining, marine and sanitary engineering. The profession of civil engineer is as old as civilized life.

Up to the middle of the 18^{th} century there were two branches of engineering – civil and military. The former included all those branches of the constructive art not directly connected with military operations and the construction of fortifications, while military engineering concerned itself with the application of science and the utilization of building materials in the art of war.

But later there came a remarkable series of mechanical inventions, great discoveries in electrical science and atomic energy. It led to the differentiation of mechanical, electrical, nuclear engineering, etc. Architecture, which up to the 18^{th} century had been considered a branch of engineering became a profession itself. The term "civil engineering" has therefore two distinct meanings. In the widest and oldest sense it includes all non-military branches of engineering as it did two centuries ago. But in the narrower, and at the present day more correct sense, civil engineering, includes mechanical engineering, metallurgical, and mining engineering. Here are some fields of civil engineering.

1. Housing, industrial and agricultural construction.
2. Structural engineering which is the construction of all fixed structures with their foundations.
3. The construction of highways and city streets and pavements.
4. The construction of railroads.
5. The construction of harbours and canals.
6. Hydraulic engineering which includes the construction of dams and power plants.

Questions:

1. What does the word “engineering” mean?
2. Is engineering divided into many branches?
3. What are the most important branches of engineering?
4. What can you say about the profession of civil engineer?
5. What branches of engineering were there in the 18th century?
6. What does civil engineering include now?
7. Can you name the fields of civil engineering?

Text 2

DEVELOPMENT OF THE HOUSE

The first houses in different countries of the world were made of wood.

At that time the greater part of our planet was covered with thick forests. Even in those days men found ways of using wood as a building material. In some places they tied together the tops of several trees and covered them with leaves or grass.

The primitive people’s first houses were tents or huts. Primitive building required no tools. The invention of tools permitted the cutting of stones and timber. Stone was the most convenient building material in countries where there was not much wood but plenty of stone.

People began to use stone widely to build their houses many centuries ago. With the development of stone cutting finer tools appeared.

The column has played an important part in the history of building. Most of the building of old times was based upon the column and beam method of construction.

About 4,000 years before our era the Egyptians possessed great constructional know-how (ability). They build simple houses by present standards. They used bricks which in their most primitive form were not burned, but were hardened by being dried in the sun. Since the middle ages, brickwork has been in constant use everywhere, in every sort of construction and in every architectural style. They made flat roofs because there was very little rain in Egypt.

Their buildings were simple in construction but very beautiful. We still admire their monuments, sphinxes and palaces.

Greek builders learned much from Egyptian builders. They built their houses with slanting roofs because the climate of these two countries differs greatly. Soon Greek builders became second to none in column making. But they added the arch, thus adding much strength and beauty to their buildings.

The use of precast concrete, a very advanced construction technique, has many advantages over other building materials. Precast building units can be assembled at the site all the year round in any weather. The precast concrete technique is constantly being improved in our country.

Questions:

1. What building material were the first houses in different countries of the world made of?
2. What ways of using wood as a building material did men find in those days?
3. What can you say about stone?
4. What became possible with the invention of tools?
5. What part has column played in the history of building?
6. What constructional ability did the Egyptians possess about 4.000 years before our era?
7. Did Greek or Egyptian builders become second to none in column making?
8. What advantages of precast concrete over other building materials do you know?

Text 3

HISTORY OF BUILDING MATERIALS

All the buildings erected nowadays are of two main types: they are intended either for housing or industrial purposes.

The main building materials are timber, stone (brick), concrete, steel, light metals, glass and plastics. Timber was one of the first materials to be used by man for constructional purposes. It is highly probable that it will be one of the last. Timber is unique among the materials of construction. It will be available when the earth's capital deposits of iron, coal, clay and the rest have been consumed.

The buildings made of stone or brick are durable and fire-proof, they have poor heat conductivity.

Concrete made with natural hydraulic binders was used in antiquity, particularly by the Romans. After the decline of the Roman Empire the art of making concrete has been forgotten, and the revival came much later.

Portland cement was produced more than a century ago. From the time of its first production there was a steady and gradual improvement in its compressive strength.

Reinforced concrete is hardly 100 years old, but its practical application in building began only 90 years ago. Today reinforced concrete is used in all civilized countries as one of the most important building materials. One of the essential properties of concrete is its compressive strength.

Questions:

1. What are buildings intended for?
2. What are the main building materials?
3. What are the earth's capital deposits?
4. When was Portland cement produced?
5. When was concrete first used?
6. What is one of the essential properties of concrete?

Text 4

THE PROPERTIES OF BUILDING MATERIALS

Materials that are used for structural purposes should meet several requirements.

In most cases it is important that they should be hard, durable, fire-resistant and easily fastened together.

The most commonly used materials are steel, concrete, stone, wood and brick. They differ in hardness, durability and fire-resistance.

Wood is the most ancient structural material. It is light, cheap and easy to work. But wood has certain disadvantages: it burns and decays.

Stone belongs to one of the oldest building materials used by man.

It is characteristic of many properties. They are mechanical strength, compactness porosity, sound and heat insulation and fire-resistance.

Bricks were known many thousands of years ago. They are the examples of artificial building materials.

Concrete is referred to as one of the most important building materials. Concrete is a mixture of cement, sand, crushed stone and water.

Steel has come into general use with the development of industry. Its manufacture requires special equipment and skilled labour.

Plastics combine all the fine characteristics of a building material with good insulating properties. It is no wonder that the architects and engineers have turned to them to add beauty to modern homes and offices.

All building materials are divided into three main groups: 1) Main building materials such as rocks and artificial stones, timber and metals. 2) Binding materials such as lime, gypsum and cement. 3) Secondary or auxiliary materials which are used for the interior parts of the buildings.

We use many building materials for bearing structures. Binding materials are used for making artificial stone and for joining different planes. For the interior finish of the building we use secondary materials.

Natural building materials are: stone, sand, lime and timber. Cement, clay products and concrete are examples of artificial building materials.

Questions:

1. What are the properties of the building materials?
2. What are the most commonly used building materials?
3. Do building materials differ from each other?
4. What can you say about the most ancient building materials?

5. Is concrete an artificial or natural building material?
6. Into what groups do we divide building materials?
7. Can you give an example of a binding material?
8. What artificial building materials do you know?

Text 5

STONE

Stone has been used as a structural material since the earliest days. Almost all famous buildings of classic times, of the medieval and Renaissance periods and of the 18th and early 19th centuries were erected of stone. The art of making any structure in stone is called stone masonry. Floors, walls or even roofs may be made of stone. Counters, fireplaces and other objects built into the structure can be stone or faced with stone. Stone can also be used for furnishings or decorative objects. Some examples are bowls, statues or sculptures.

As a material stone has the advantage that it doesn't burn at household temperatures. It can have interesting and varied textures. Generally natural stones are resistant to heat scratch, stains, spills, moistures. They produce a shine for a long time because of their durability and resistance. As a natural building material, stone contains no pollutants that are damaging to the health. Stone provides insulation. Stone can hold up under the weather better than any other materials. Things made of stone can last a long time – even centuries.

On the other hand, stone has some disadvantages. If exposed to extreme cold or rapid changes in temperature, stone may crack. It may appear cold or barren. Stone is generally heavier and more expensive than other materials.

Nowadays, most of the people come to know about the usage and purpose of natural stones. With the advancement and improvements of technology, natural stones are used almost in all buildings, homes and monuments. Most of natural stones like granite, marble, limestone and others come in different colors and design to satisfy needs and desires of the homeowners and builders.

Questions:

1. When did people begin to use stone as a structural material?
2. What is called stone masonry?
3. What can stone be used for?
4. What are the advantages of stone over other building materials?
5. What are stone's disadvantages?
6. What do you know about the usage and purpose of natural stones?

Text 6

TIMBER

In many regions of the world timber construction has traditions that go back hundred, even thousands of years, when nearby forests made the material readily available. Timber is the most ancient structural material. In comparison with steel timber is lighter, cheaper, easier to work and its mechanical properties are good. Timber construction elements are mostly uniform and undergo almost no changes in dimension as a result of variations in humidity. Over hundreds of years, experience has shown that timber is a healthy material for living. Timber is diffusible, hydroscopic, and filters the air – its humidity regulating properties have positive effects on the atmospheric conditions of a room. The excellent insulation qualities of timber structures in combination with proper insulating materials, its high surface heat, ability to absorb sounds, lack of electrostatic charge and low level of electric conductivity create a pleasant atmosphere. On the other hand, timber has certain disadvantages. First, it burns and is therefore unsuitable for fireproof buildings. Second, it decays.

Timber is a name applied to the cut material derived from trees. Timber used for building purposes is divided into two groups: softwoods and hardwoods. Hardwoods are chiefly used for decorative purposes, as for paneling, veneering in furniture, and some of them are selected for structural use because of their high strength and durability. In modern construction timber is often used for window and door frames, flooring, fences and gates, wallplates, for temporary buildings and unpainted internal woodwork.

Timber cannot be used for either carpenters' or joiners' work immediately it has been felled because of the large amount of sap which it contains. Most of this moisture must be removed, otherwise the timber will shrink excessively, causing defects in the work and a tendency to decay. Elimination of moisture increases the strength, durability and resilience of timber.

Questions:

1. Is timber a very ancient structural material?
2. What are the advantages of timber in comparison with steel?
3. What are the disadvantages of timber?
4. Into what two groups is timber, used for building purposes, divided?
5. For what purposes are hardwoods chiefly used?
6. Why cannot timber be used for work immediately it has been felled?
7. What increases the strength, durability and resilience of timber?

Text 7

METALS

In general, metals are used in various constructions and different industries. All metals are divided into ferrous metals and non-ferrous metals. Ferrous metals include iron, steel and its alloys. Non-ferrous metals are metals and alloys the main component of which is not iron but some other element. Metals, and especially ferrous metals are of great importance.

Metals possess the following properties: 1) All metals have specific metallic luster. 2) They can be forged. 3) Metals can be pulled. 4) All metals, except mercury, are hard substances. 5) They can be melted. 6) In general, metals are good conductors of electricity.

These characteristics are possessed by all metals but the metals themselves differ from one another. Steel and cast iron are referred to the group of ferrous metals. Cast iron is the cheapest of the ferrous metals. It is chiefly used in building for compressed members of construction, as the supporting members.

There are different kinds of steel. Alloyed steel (or special steel) is corrosion-resistant steel. This kind of steel is widely used in building. Stainless steel is also corrosion-resistant steel. It is used for cutlery, furnace parts, chemical plant equipment, valves, ball-bearings, etc.

When an engineer designs a steelwork he must carefully consider that the steel frame and every part of it should safely carry all the loads imposed upon it. It is steel and metal that is employed as reinforcement in modern ferroconcrete structures.

Iron and steel are used widely in the construction of roads, railways, other infrastructure, appliances, and buildings. Most large modern structures, such as stadiums and skyscrapers, bridges and airports, are supported by a steel skeleton. Despite growth in usage of aluminium, it is still the main material for car bodies. Steel is used in a variety of other construction materials, such as bolts, nails, and screws. Other common applications include shipbuilding, pipeline transport, mining, offshore construction, aerospace, heavy equipment.

Questions:

1. What do ferrous metals include?
2. Is iron the main component of non-ferrous metals?
3. What properties do metals possess?
4. Do the metals themselves differ from one another?
5. Where is alloyed steel widely used?
6. What do you know about stainless steel?
7. What must an engineer carefully consider when he designs a steelwork?
8. Can you name the branches of industry where steel is widely used?

Text 8

CONCRETE

It is difficult to imagine modern structure without concrete. Concrete is the very building material which led to great structural innovations. The most important quality of concrete is its property to be formed into large and strong monolithic units. The basic materials for making concrete are cement, aggregate and water. Cement is the most essential material and the most important one for making concrete of high quality. Cement is made of limestone and clay. It is burnt (calcined) at high temperature and ground up into powder. Depending on the kind and composition of the raw materials different types of cement are obtained. Portland cement, blast furnace cement are suitable for putting up marine structures.

Concrete is made by mixing cement, water, sand and gravel in the right amount. As soon as it is thoroughly mixed it is poured into forms that hold it in place until it hardens. The crystals forming in the process of making concrete stick together in a very hard artificial stone. Cement starts hardening one hour after the water has been added and the process of hardening lasts for about twenty-eight days. The process is called concrete curing.

The characteristics of concrete depend upon the quality of the materials used, grading of the aggregates, proportioning and amount of water. The most important requirements for concrete are: it should be hard, strong, durable, fire-resistant and economical. Concrete can be divided into two classes: mass or plain concrete and reinforced concrete (ferro-concrete) where it is necessary to introduce steel. Plain or mass concrete can be used for almost all building purposes. Ferro-concrete is used in building bridges and arches, dams and dock-walls, for structures under water, for foundations, columns, girders, beams. The use of concrete and ferro-concrete is almost universal.

Builders now produce two types of new building materials: alkali-slag concrete and silica concrete. These new materials have been tested successfully and are now being widely used.

Questions:

1. Is it possible to put up modern structures without using concrete?
2. Do you know what the most important quality of concrete is?
3. What is the most essential material for making concrete?
4. Can we make cement if we take limestone and clay?
5. What are Portland and blast furnace cement suitable for?
6. How is concrete made?
7. When does cement start hardening?
8. How long does the process of hardening last?
9. Can you say what the characteristics of concrete depend upon?
10. Into what two classes can concrete be divided?
11. Is the use of concrete and ferro-concrete most universal?
12. What new materials do builders produce now?

Text 9

REINFORCED CONCRETE

Reinforced concrete is a combination of two of the strongest structural materials, concrete and steel.

This term is applied to a construction in which steel bars or heavy steel mesh are properly embeded in concrete. The steel is put in position and concrete is poured around and over it, then tamped in place so that the steel is completely embeded. When the concrete hardens and sets, the resulting material gains great strength. This new structural concrete came into practical application at the turn of the 19^{th} century. The first results of the tests of the reinforced concrete beams were published in 1887. Since that time the development of reinforced concrete work has made great progress. And the reasons of this progress are quite evident. Concrete has poor elastic and tensional properties, but it is rigid, strong in compression, durable under and above ground and in the presence or absence of air and water, it increases its strength with age, it is fireproof.

Steel has great tensional, compressive and elastic properties, but it is not durable being exposed to moisture, it loses its strength with age, or being subjected to high temperature. So, what is the effect of the addition of steel reinforcement to concrete?

Steel does not undergo shrinkage or drying but concrete does and therefore the steel acts as a restraining medium in a reinforced concrete member. Shrinkage causes tensile stresses in the concrete which are balanced by compressive stresses in the steel. For getting the best from reinforced concrete the following consideration should be kept in mind:

1. For general use the most suitable proportions of cement and aggregate are: 1 part cement, 2 parts sand and 4 parts of gravel.

2. Only fresh water free from organic matter should be used for reinforced work. Sea water is not allowed.

3. Homogeneity of the concrete is a very important requirement. Steel constructions with reinforced concrete have become the most important building materials invented in centuries and they have given modern architecture its peculiar features.

Questions:

1. Is reinforced concrete a combination of two of the strongest structural materials?
2. What is the process of making reinforced concrete?
3. When did this new structural concrete come into practical application?
4. Since when has the development of reinforced concrete work made good progress?
5. Can you name the properties of concrete?
6. Will you say a few words about the properties of steel?
7. Does concrete increase its strength with age?
8. Is it true that steel does not undergo shrinkage or drying but concrete does?
9. Shrinkage causes tensile stresses in the concrete, doesn't it?

Text 10

PRESTRESSED CONCRETE

Prestressed concrete is not a new material. Its successful use has been developed rapidly during the last two decades, chiefly because steel of a more suitable character has been produced.

Concrete is strong in compression but weak when used for tensile stresses.

If, therefore, we consider a beam made of plain concrete, and spanning a certain distance, it will at once be realized that the beam's own weight will cause the beam to "sag" or bend. This sagging at once puts the lower edge of the beam in tension, and if the cross-sectional area is small, causes it to break, especially if the span is relatively large.

If, on the other hand, we use the beam of similar cross-section, but incorporate steel bars in the lower portion, the steel will resist the tensile stress derived from the sag of the beam, and thus preventing it from breaking.

In prestressed concrete steel is not used as reinforcement, but as a means of producing a suitable compressive stress in the concrete. Therefore any beam or (member) made of prestressed concrete is permanently under compression, and is consequently devoid of cracks – under normal loading, or so long as the "elastic limit" is not exceeded.

Prestressed concrete is not only used for beams but is now employed extensively for columns, pipes, and cylindrical water-towers, storage tanks, etc.

Questions:

1. Is prestressed concrete a new building material?
2. How long has prestressed concrete been used in construction?
3. What disadvantages does plain concrete have?
4. What is steel used in prestressed concrete for?
5. What will happen if "elastic limit" of a beam is exceeded?
6. What is prestressed concrete used for?

Text 11

DIALOGUES

I. – What do you know about cement?

– It's a powder which, when mixed with water, becomes hard like stone.

– Suppose we mix cement with sand and stones?

– If we mix cement with sand and stones we get concrete.

II. – Do you know what a brick is?

– Yes, I do. It is a block of baked clay.

– What are bricks chiefly used for?

– They are chiefly used for building houses.

III. – Suppose you wanted to make some concrete, what would you take?

– I'd take some cement, gravel and sand. Then I'd mix them with water.

– Quite right! Now what is concrete used for?

– It is used for building, making roads, etc.

IV. – What is lime? Do you know?

– It's a white substance obtained by burning limestone.

– Is it used in making cement and mortar?

– Right. It' used in making cement and water.

V. – What sort of a mixture is mortar?

– It's a mixture of lime, sand and water.

– What is it used for?

– It's used to hold bricks, stones, etc. together.

Text 12

SOME IMPORTANT FACTS ABOUT BUILDING MATERIALS

Density is the amount of mass in a unit volume. It is measured in kilograms per cubic meter. The density of water is 1000 kg/m^3 but most materials have a higher density. Aluminium alloys, with typical densities around 2800 kg/m^3 are considerably less dense than steels, which have typical densities around 7800 kg/m^3. Density is important in any application where the material must not be heavy.

Stiffness is a measure of the resistance to deformation such as stretching or bending. The Young modulus is a measure of the resistance to different stretching or compression. It is the ratio of the applied force per unit area to the fractional elastic deformation. Stiffness is important when a rigid structure is to be made.

Strength is the force per unit area that a material can support without failing. The units are the same as those of stiffness, but in this case the deformation is irreversible. The yield strength is the point at which a material first deforms plastically. For a metal the yield strength may be less than the fracture strength. It is the stress at which it breaks. Many materials have a higher strength in compression than in tension.

Ductility is the ability of a material to deform without breaking. One of the great advantages of metals is their ability to be formed into the shape that is needed, such as car body parts. Materials that are not ductile are brittle. Ductile materials can absorb energy by deformation but brittle materials cannot.

Toughness is the resistance of a material to breaking when there is a crack in it. For a material of given toughness, the stress at which it will fail is inversely proportional to the square root of the size of the largest defect present. Toughness is different from strength. For example, the toughest steels are different from the ones with the highest tensile strength. Brittle materials have low toughness. For example, glass can be broken along a chosen line by first scratching it with a diamond. Composites can be designed to have considerably greater toughness than their constituent materials. The example of a very tough composite is fiberglass that is very flexible and strong.

Creep resistance is the resistance to a gradual permanent change of a shape, and it becomes especially important at higher temperatures. A successful research has been made in materials for machine parts that operate at high temperatures and under high tensile forces without gradually extending. For example, they can be parts of plane engines.

Questions:

1. Is density the amount of mass in a unit volume?
2. Is it measured in kilograms per cubic meter?
3. Is density important in any application where the material must not be heavy?
4. Is stiffness a measure of the resistance to deformation such as stretching or bending?
5. Is strength the force per unit area that a material can support without failing?
6. Is toughness the resistance of a material to breaking when there is a crack in it?
7. Is creep resistance the resistance to a gradual permanent change of shape?

Text 13

ADVANCED COMPOSITE MATERIALS

Composite materials are among the oldest and newest of structural materials. Men discovered early that when two or more materials are used together as one, the combination often behaves better than each of the materials alone. Following this principle they combined clay and straw to make bricks. Then with some notable exceptions, the further potentialities of composite materials remained virtually untapped for centuries while monolithic materials, such as iron and copper, served the major needs of an advancing technology. Even in the more recent times with the coming of reinforced concrete, linoleum, plasterboard and plywood panels were somewhat out of mainstream of materials development and technology.

During the 1930's and 1940's, however, light-weight honeycomb structures, machine parts made from compressed metal powders and plastic reinforced with glass fibers become commercial realities. These developments marked the beginning of the modern era of composite engineering materials. The use of composite materials has been steadily growing. The consumption of the fiber reinforced plastics, for example, has been increasing at the phenomenal rate.

There are two major reasons for the current interest in composite materials. The first is the demand for materials that will outperform the traditional monolithic materials. The second, and the more important in the long run, is that composites offer engineers the opportunity to design totally new materials with the precise combination of properties needed for a specific task. Although the new composites are usually more costly than conventional materials, they can be used more sparingly, because of their superior qualities.

Questions:

1. What is characteristic of composite materials?
2. Can you give examples of the oldest composite materials?
3. What is the present tendency in the use of composite materials?
4. What are the main reasons for the interest in composite materials?
5. Why do engineers insist on using composite materials despite their high cost?

SECTION II

TEXTS FOR READING AND DISCUSSION

Types of construction

It is important for an engineer to know that all building materials are used in two basic ways. In the first way they are used to support the loads on a building and in the second way they are used to divide the space in a building. But it is more important to realize that building components are made from building materials. At the same time the form of a component is related to the way in which it is used. We can see how this works by considering three different types of any construction:

1. The first type of a construction is made of building materials such as brick, stone or concrete. They are called blocks. The blocks are put together to form solid walls. These materials are heavy. They can support the structural loads because they have the property of high

compressive strength. At the same time the walls made up of blocks support the building and divide the space in the building.

2. The second type of a construction is made of sheet materials. They are used to form walls which act as both space-dividers and structural support. Timber, concrete and some plastics can be made into large rigid sheets and fixed together to form a building. Such kind of buildings is lighter and faster to construct than a building made up of blocks.

3. The third type of a construction is made of rod materials. They can be used for structural support but not for dividing spaces. There timber, steel and concrete can be formed into rods. Usually rod materials are used as columns because of high tensile and compressive strength. On the other hand, they can be fixed together to form framed structures. The spaces between the rods can be filled with light sheet materials which act as space-dividers but not support structural loads.

Portland Cement

Portland cement is the most common type of cement in general usage, as it is a basic ingredient of concrete, mortar and plaster. It consists of a mixture of oxides of calcium, silicon and aluminium. Portland cement and similar materials are made by heating limestone (a source of calcium) with clay or sand (a source of silicon) and grinding this product (called clinker) with a source of sulfate (most commonly gypsum).

Portland cement was first manufactured in Britain in the early part of the 19th century, and its name is derived from its similarity to Portland Stone, a type of building stone that was quarried on the Isle of Portland in Dorset, England. The patent for Portland cement was issued to Joseph Aspdin, a British bricklayer, in 1824.

The most common use for Portland cement is in the production of concrete. When water is mixed with Portland cement, the product sets in a few hours and hardens over a period of weeks. These processes can vary widely depending upon the mix used and the conditions of curing of the product.

The gradual improvement in Portland cement quality from the time of its introduction led to the elaboration of rapid-hardening Portland cement or “high early strength”. Portland cement can to some extent be modified to suit a particular application. The scope for such purpose-made cements has led to the development of an increasing variety as high alumina cement, blast-furnace slag and puzzolanas. Puzzolanic cement consists of mixtures in varying proportions of Portland cement and puzzolana. Puzzolanic cements have greater resistance to some forms of chemicals.

Three Fundumental Groups of Construction Materials

With few exceptions, construction materials are solid materials or harden into solid materials. Solid materials are grouped into three fundamental types: ceramics, metals and organics.

The ceramic materials are rock or clay minerals, or are compounded from such minerals. Examples are sand, limestone, glass, brick, cement, gypsum, plaster, mortar, and mineral wool insulation. These are materials dug from the earth’s crust with or without further processing and purification. Since they are extracted from the earth, they are relatively inexpensive as compared to metals or the organic materials. The ceramics have been used as building materials from time immemorial, and their virtues will ensure their use in the future: they are enduring, hard, and rigid. Their outstanding disadvantages are brittleness and heavy weight.

Metals are extracted from natural ores, which of course are also ceramic materials. Such metallic ores are usually oxides or sulfides of metals. The metals are not as hard as the ceramic materials and, because they must be extracted from the ore by complex smelting processes, they are more expensive. Ceramic materials are brittle, and so are restricted to the carrying of compressive forces in buildings and structures. Metals are ductile and are used where tensile forces must be carried.

Ceramic materials do not corrode in the atmospheric conditions to which buildings are exposed; metals do. The corrosion process returns the metal to its original state as a mineral. When iron or steel rust, they oxidize to iron oxide, Fe_2O_3, which is the iron ore hematite. Aluminum oxidizes to Al_2O_3, which is the ore bauxite.

The organic materials are largely a development of the twentieth century, with notable exception of wood and bitumens. These are numerous and increasing synthetic materials based chemically upon carbon. The organics include wood, paper, asphalts, plastics, and rubbers. The organic materials are the lightest in weight of all the construction materials.

Concrete

Concrete is a composite construction material, composed of cement (commonly Portland cement) and other cementitious materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravel or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water and chemical admixtures.

The word concrete comes from the Latin word "concretus" (meaning compact or condensed), the perfect passive participle of "concrescere", from "con"- (together) and "crescere" (to grow).

Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a robust stone-like material. Concrete is used to make pavements, pipes, architectural structures, foundations, motorways/roads, bridges/overpasses, parking structures, brick/block walls and footings for gates, fences and poles.

Concrete is used more than any other man-made material in the world. As for 2006, about 7.5 cubic kilometers of concrete were made each year – more than one cubic meter for every person on Earth.

Concrete powers a US $35 billion industry, employing more than two million workers. More than 55,000 miles (89,000 km) of highways in the United States are paved with this material. Reinforced concrete, prestressed concrete and precast concrete are the most widely used types of concrete functional extensions in modern days.

Concrete has been used for construction in various ancient structures. An analysis of ancient Egyptian has shown that concrete may have been employed in their construction, although its composition would have differed from modern concrete.

During the Roman Empire, Roman concrete was made from quicklime, puzzolana and an aggregate of pumice. Its widespread use in many Roman structures, a key event in the history of architecture termed the Roman Architectural Revolution, freed Roman construction from the restrictions of stone and brick material and allowed for revolutionary new designs in terms of both structural complexity and dimension.

Hardian's Pantheon in Rome is an example of Roman concrete construction.

Concrete, as the Romans knew it, was a new and revolutionary material. Laid in the shape of arches, vaults and domes, it quickly hardened into a rigid mass, free from many of the internal thrusts and strains that trouble the builders of similar structures in stone or brick.

Modern tests show that Roman concrete had as much compressive strength as modern Portland-cement concrete. However, due to the absence of steel reinforcement, its tensile strength was far lower and its mode of application was also different.

Modern structural concrete differs from Roman concrete in two important details. First, its mix consistency is fluid and homogeneous, allowing it to be poured into forms rather than requiring hand-layering together with the placement of aggregate, which, in Roman practice, often consisted of rubble. Second, integral reinforcing steel gives modern concrete assemblies great strength in tension, whereas Roman concrete could depend only upon the strength of the concrete bonding to resist tension.

The widespread use of concrete in many Roman structures has ensured that many survive to the present day. The Baths of Caracalla in Rome are just one example. Many Roman aqueducts and bridges have masonry cladding on a concrete core, as does the dome of the Pantheon.

Plastic Materials

Many new materials are familiar to us over centuries. We are pretty well acquainted with the advantages and disadvantages of wood. We know that glass is transparent, but in some ways it is rather brittle. Glass has the advantages of cheapness, rigidity and chemical inertness. We are aware that most metals can stand severe handling, but some of them rust.

But such materials as plastic materials are not found in nature. The term plastics is derived from the Greek “plasticos” meaning “capable of being moulded” and covers a wide variety of artificial organic resins, which alone or in combination with other materials, can be transformed by either heat or pressure, or both, into products with special characteristics and uses. Some years ago plastics were little more than laboratory curiosities. Today plastics are conceived in the laboratory of the chemical plant. But plastic is formed by extrusion or injection molding under very high pressure. It can be molded into any desired shape. Organic plastics are divided into two general groups: thermosetting and thermoplastic. The thermosetting group becomes rigid through a chemical change that occurs when heat is applied. These plastics cannot be remolded. The thermoplastic group remains soft at high temperatures and must be cooled before becoming rigid. This group is not used generally as a structural material.

Plastics are rapidly becoming important construction materials because of their variety, strength, durability and lightness. The high strength to weight ratio of some plastics offers big field in the coming age of space travels and rockets. Plastics are light. The same benefits of light weight coupled with good strength and absence of corrosion offer tremendous potential as alternatives to traditional building materials. A given volume of polythene weights less than one-eighth of an equal volume of iron and less than half of the same volume of aluminium. The following characteristics of plastics are usually shared by all plastics: lightweight, corrosion resistance, electrical and thermal insulation, ease of fabrication, transparency and economy of production.

These characteristics of plastics explain their increasing acceptance by industries. We can hardly name a branch of industry where plastics are not applied. Plastic products offer many advantages over the materials they replace, such as ease of handling, lower maintenance costs and rapidity of assembly. The insulation and dielectric properties of plastics led to their early use in the electrical engineering industry, which was followed by special application in mechanical engineering. Plastic materials are widely used in car manufacturing, shipping, microelectronics and other engineering industries.

Application of plastics as materials for construction in the form of sheets, rods or tubes is substituting the conventional metals. Plastics offer a lot of properties for the designs. They can be applied to almost every branch of building, from the laying of foundations to the final coat of paint.

Glass

Glass is an amorphous (non-crystalline) solid material. Glass, as a substance, plays an essential role in science and industry. Its chemical, physical and in particular optical properties make it suitable for applications such as flat glass, container glass, optics and optoelectronics material, laboratory equipment, thermal insulator(glass wool), reinforcement materials (glass-reinforced plastic, glass fiber reinforced concrete), and glass art (art glass, studio glass).

The history of creating glass can be traced back to 3500 BCE in Mesopotamia. The term glass developed in the late Roman Empire. It was in the Roman glassmaking center at Trier, now in modern Germany, that the late-Latin term “glesum” originated, probably from a Germanic word for a transparent, lustrous substance.

Soda-lime glass

Many types of glass are produced, but only soda-lime glass is of significance for the construction industry. Silica sand is the basis of glass. This is a remarkably pure white sand, virtually pure silica, usually consisting of fine grains of 50 to 100 mesh cemented together with caolin. For glass manufacture a maximum iron oxide content of about 0.25 per cent is allowed, since the presence of iron oxide will give the glass a brown color.

Silica and soda combine chemically to produce a glassy substance called sodium silicate (water glass), which is soluble in water and is used in large quantities as an adhesive in paper bag manufacture. If lime is added to this chemical reaction, the solubility of the product in water is reduced. When sufficient lime is added, a relatively insoluble glass product results, which may however, still be attacked by water under certain circumstances is of no interest to the construction industry.

Soda-lime glass, like most glasses, is not technically a solid but a super-cooled liquid. A solid is a material that crystallizes from the liquid state at a definite melting temperature. When molten glass is cooled, it tends to crystallize, but its high viscosity prevents movements of the atoms to form crystals. The liquid state becomes “frozen in,” making glass amorphous (non-crystalline). The amorphous condition is technically a liquid condition. Actually glass properties are unfavorably affected if crystals develop in the glass.

Special types of glass

Wired glass has a wire mesh inserted in the glass to prevent the glass from shattering into dangerous shards under impact. Laminated safety glass has the same safety characteristics but with better appearance. Laminated safety glass is made from two thicknesses of sheet glass bonded with polyvinyl butyral, a transparent adhesive. This type of glass was first used, and is still used, for front windows of automobiles.

Tempered plate glass is a strong glass highly resistant to impact and thermal shock. It is made by a reheating and sudden cooling cycle that puts the outer surfaces of the glass under a residual compressive stress. As a result, the glass cannot readily break in tension as can an ordinary glass sheet. Tempered glass is used for swinging doors, sliding doors, and windows in sports arenas.

Vitreous colored plate glass is a strengthened and coated glass used for curtain walls and building fronts. The vitreous coat is a color coat fused to the glass surface. This is not a glazing material, but is applied instead of masonry or other backup material.

Foamed glass is a high-porosity heat insulating material, available in blocks made of fine-ground glass and a frothing agent.

Foamed glass is widely used in prefabricated house-building, to ensure heat insulation of exterior wall panels, and in industrial construction.

Foamed glass has a high mechanical strength, is distinguished by moisture, vapour and gas impermeability. It is non-inflammable, offers resistance to frost, possesses a high sound adsorption, and it is easily sewn and nailed.

Structural foamed-glass blocks are designed to fill ceilings, and to make interior partitions in buildings and rooms, ensuring heat and sound insulation.

Heat-and-moisture resistant foamed glass is used for heat insulation of surfaces at a service temperature up to 190 ^{o}C.

Structural elements and goods of decorative-acoustic foamed glass are designed to ensure interior sound proofing and decorative finish.

Brick

A brick is a block of ceramic material used in masonry construction, usually laid using various kinds of mortar. It has been regarded as one of the longest lasting and strongest building materials used throughout history.

Clay is the material most often associated with bricks, but since the late 19th century other materials have been used. “Bricks” for building may be made from clay, shale, soft slate, calcium silicate, concrete, or shaped from quarried stone. However, true bricks are ceramic, and therefore created by the action of heat and cooling.

History. The oldest discovered bricks, originally made from shaped mud and dating to before 7500 B.C. were found at Tell Aswad then later in the upper Tigris region and in southeast Anatolia close to Diyarbakir. Other more recent findings, dated between 7.000 and 6.395 B.C., come from Jericho. The first sun-dried bricks were made in Mesopotamia (what is now Iraq), in the ancient city of Ur.

Other examples of civilizations who used mud brick include the ancient Egyptians and the Indus Valley Civilization, where it was used exclusively. The Romans made use of fired bricks, and the Roman legions, which operated mobile kilns, introduced bricks to many parts of the empire. Roman bricks are often stamped with the mark of the legion that supervised their production. The use of bricks in southern and western Germany, for example, can be traced back to traditions already described by the Roman architect Vitruvius.

Shape. Not all bricks are completely solid. Some have “frogs” in them. A frog is a recess in the brick named after the frog in horse’s hoof. They make it easier to press and fire the bricks and also reduce the weight. Lighter bricks are easier to handle and cheaper to transport. Nowadays many machine-made bricks have holes in them for similar reasons. These are called perforated bricks. “Specials,” as the name suggests, are bricks made for a specific purpose. They are usually shaped to fit angles and curves or to produce a decorative effect. There are various commonly made ones such as “angled”, “radial”, and “bull-nosed”.

Color. The color of clay bricks depend on several factors. The type of clay used, chemicals in the clay, the supply of oxygen while the bricks are being fired, and the temperature the bricks reach during firing. The colors range from dark purple to light yellow. The red color of ordinary brick is due to the iron found in most clay. A large amount of iron gives a bright-red color, reducing the supply of oxygen may give dark-blue. By adding manganese to the clay a brown color is produced. Clay combined with lime produces yellow bricks.

Sand-lime bricks are naturally white, off-white, or pink, depending on the sand used to make them. By adding pigments, any colors from pale pastels to dark tones can be produced.

Use. Bricks are used for building, block paving and pavement. In the USA, brick pavement was found incapable of withstanding heavy traffic, but it is coming back into use as a method of traffic calming or as a decorative surface in pedestrian precincts.

Bricks in the metallurgy and glass industries are often used for lining furnaces, in particular refractory bricks such as silica, magnesia, chamotte and neutral (chromomagnesite) refractory bricks. This type of brick must have good thermal shock resistance, refractoriness under load, high melting point, and satisfactory porosity. There is a large refractory brick industry, especially in the United Kingdom, Japan, the United States, and the Netherlands.

Engineering bricks are used where strength, low water porosity or acid (flue gas) resistance are needed.