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Betonul armat şi betonul precomprimat constituie în prezent unele din cele mai importante materiale folosite la executarea elementelor structurale ale construcțiilor cu cele mai variate destinații: civile, industriale, hidrotehnice, căi de comunicații, poduri, etc. Ca materiale structurale, acestea sunt în mult mai mică măsură expuse capriciilor modei, în comparație cu materialele de finisaj, de compartimentare sau a dotărilor şi echipamentelor, a căror înlocuire la intervale mai mici sau mai mari de timp este inevitabilă. Nu sunt rare exemplele de construcții industriale din beton armat de vârstă aproape seculară care adăpostesc în prezent cu succes procese tehnologice echipate cu utilaje din cele mai noi generații.

Necesitatea realizării unor construcții de calitate se impune şi prin prisma consecințelor pregnant dezavantajoase în cazuri de eşec. Reutilizările elementelor structurale din beton armat şi precomprimat sunt foarte greoaie şi foarte costisitoare, recuperarea materialelor o dată folosite fiind practic imposibilă, iar riscul pierderii de vieți omeneşti în cazul unor accidente grave (prăbuşiri de construcții) are efecte psihologice nefaste şi consecințe sociale severe.

Probabilitatea de risc în cazul construcțiilor din beton armat şi beton precomprimat poate fi redusă în mare măsură când calitatea acestora este cea dorită.

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La proiectarea şi executarea unei construcții, indiferent de natura ei, trebuie să se adopte structura cea mai convenabilă şi sistemul de realizare cel mai potrivit. Alegerea acestora depinde de o serie de factori, dintre care cei mai însemnați sunt: destinația construcției, caracterul permanent sau provizoriu al ei, materialele de care se dispune, natura terenului pe care se va fonda construcția şi probabilitatea fenomenelor seismice, condițiile specifice climatului, cerințele arhitecturale şi urbanistice, necesitățile de fono, termo şi hidroizolare şi de siguranță contra incendiilor, posibilitățile de execuție – utilaj şi mână de lucru, timpul disponibil pentru execuție şi termenul de dare în folosință, problemele economice – prețul de cost, costul întreținerii şi al producției (manoperă şi cheltuieli indirecte).

Aceşti factori determină şi, totodată, limitează domeniile de aplicare a diferitelor sisteme de realizare a construcțiilor. Oricare ar fi sistemul de realizare şi tipul de construcție, pentru a îndeplinii în condiții bune rolul ce-i revine, o construcție trebuie să îndeplinească următoarele condiții: să corespundă destinației, să asigure un anume confort corespunzător vieții şi procesului de producție ce se desfăşoară în ea, să fie rezistentă şi durabilă, să fie realizată în concordanță cu regulile de construcție, să corespundă regulilor sanitare, să fie estetică, să prezinte garanții suficiente contra incendiilor, a cutremurelor, etc.

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Civil engineering is a professional engineering discipline that deals with the design, construction and maintenance of the physical and naturally built environment, including works such as bridges, roads, canals, dams and buildings. Civil engineering is the oldest engineering discipline after military engineering, and it was defined to distinguish it from military engineering. It is traditionally broken into several sub-disciplines including environmental engineering, geotechnical engineering, structural engineering, transportation engineering, water resources engineering, materials engineering, coastal engineering, surveying, and construction engineering. Civil engineering takes place on all levels: in the public sector from municipal through to federal levels, and in the private sector from individual homeowners through to international companies.

Until modern times there was no clear distinction between civil engineering and architecture, and the term engineer and architect were mainly geographical variations referring to the same person, often used interchangeably. In the 18th century, the term civil engineering began to be used to and exchange, and in the construction of ports, harbours, moles, breakwaters and lighthouses, and in the art of distinguish it from military engineering.

Civil engineering is the application of physical and scientific principles, and its history is intricately linked to advances in understanding of physics and mathematics throughout history. Because civil engineering is a wide ranging profession, including several separate specialized sub-disciplines, its history is linked to knowledge of structures, materials science, geology, soils, hydrology, environment, mechanics and other fields.

Throughout ancient and medieval history most architectural design and construction was carried out by artisans, such as stone masons and carpenters, rising to the role of master builder. Knowledge was retained in guilds and seldom supplanted by advances. Structures, roads and infrastructure that existed were repetitive, and increases in scale were incremental.

One of the earliest examples of a scientific approach to physical and mathematical problems applicable to civil engineering is the work of Archimedes in the 3rd century BC, including Archimedes Principle, which underpins our understanding of buoyancy, and practical solutions such as Archimedes' screw. Brahmagupta is considered to be the first to use arithmetic for civil engineering. Brahmagupta used arithmetic based on Hindu-Arabic numerals for canal construction, excavation and volume computations.

The practice of designing, constructing, and operating buildings is normally a collective effort of different groups of professionals and trades. Depending on the size, complexity, and purpose of a particular building project, the project team may include:

- A real estate developer who secures funding for the project;
- One or more financial institutions or other investors that provide the funding
- Local planning and code authorities
- A Surveyor who performs an ALTA/ACSM and construction surveys throughout the project;
- Construction managers who coordinate the effort of different groups of project participants;
- Licensed architects and engineers who provide building design and prepare construction documents;
- Landscape architects;
- Interior designers;
- Other consultants;
- Contractors who provide construction services and install building systems such as climate control, electrical, plumbing, Decoration, fire protection, security and telecommunications;
- Marketing or leasing agents;
- Facility managers who are responsible for operating the building.

Regardless of their size or intended use, all buildings must comply with zoning ordinances, building codes and other regulations such as fire codes, life safety codes and related standards.

Building construction is the process of adding structure to real property. The vast majority of building construction projects are small renovations, such as addition of a room, or renovation of a bathroom. Often, the owner of the property acts as laborer, paymaster, and design team for the entire project. However, all building construction projects include some elements in common - design, financial, and legal considerations. Many projects of varying sizes reach undesirable end results, such as structural collapse, cost overruns, and/or litigation reason, those with experience in the field make detailed plans and maintain careful oversight during the project to ensure a positive outcome.

Building construction is procured privately or publicly utilizing various delivery methodologies, including hard bid, negotiated price, traditional, management contracting, construction management-at-risk, design & build and design-build bridging.

In the modern industrialized world, construction usually involves the translation of paper or computer based designs into reality. A formal design team may be assembled to plan the physical proceedings, and to integrate those proceedings with the other parts. The design usually consists of drawings and specifications, usually prepared by a design team including architects, interior designers, surveyors, civil engineers, cost engineers (or quantity surveyors), mechanical engineers, electrical engineers, structural engineers, and fire protection engineers. The design team is most commonly employed by (i.e. in contract with) the property owner. Under this system, once the design is completed by the design team, a number of construction companies or construction management companies may then be asked to make a bid for the work, either based directly on the design, or on the basis of drawings and a bill of quantities provided by a quantity surveyor. Following evaluation of bids, the owner will typically award a contract to the lowest responsible bidder.

The modern trend in design is toward integration of previously separated specialties, especially among large firms. In the past, architects, interior designers, engineers, developers, construction managers, and general contractors were more likely to be entirely separate companies, even in the larger firms. Presently, a firm that is nominally an "architecture" or "construction management" firm may have experts from all related fields as employees, or to have an associated company that provides each necessary skill. Thus, each such firm may offer itself as "one-stop shopping" for a construction project, from beginning to end. This is designated as a "design Build" contract where the contractor is given a performance specification, and must undertake the project from design to construction, while adhering to the performance specifications.

Several project structures can assist the owner in this integration, including design-build, partnering, and construction management. In general, each of these project structures allows the owner to integrate the services of architects, interior designers, engineers, and constructors throughout design and construction. In response, many companies are growing beyond traditional offerings of design or construction services alone, and are placing more emphasis on establishing relationships with other necessary participants through the design-build process.

The increasing complexity of construction projects creates the need for design professionals trained in all phases of the project's life-cycle and develop an appreciation of the building as an advanced technological system requiring close integration of many sub-systems and their individual components, including sustainability. Building engineering is an emerging discipline that attempts to meet this new challenge.

Express your opinions in relation to the following text:

ROOFS WITH COOLING EFFECT

Builders have known for decades that white roofs reflect the sun's rays and lower the cost of air conditioning. But now scientists say they have quantified a new benefit: slowing global warming. If the 100 biggest cities in the world installed white roofs and changed their pavement to more reflective materials – say, concrete instead of asphalt-based material – the global cooling effect would be massive, according to data released at California's annual Climate Change Research Conference in Sacramento. Since 2005, California has required that flat commercial structures have white roofs. Next year, new and retrofitted residential and commercial buildings, with both flat and sloped roofs, will have to install heat-reflecting roofing, as part of an energy-efficient building code. But the state has yet to pass any rules to encourage cooler pavement on its roads, which are largely coated with heat-absorbing asphalt, a cheap byproduct of oil refining.

According to Hashem Akbari, a physicist with the Lawrence Berkeley National Laboratory, a 1,000-square-foot roof – the average size on an American home – offsets 10 tons of planet-heating carbon dioxide emissions in the atmosphere if dark-colored shingles or coatings are replaced with white material. Globally, roofs account for 25% of the surface of most cities, and pavement accounts for about 35%. If all were switched to reflective material in 100 major urban areas, it would offset 44 gigatons of greenhouse gases, which have been trapping heat in the atmosphere and altering the climate on a potentially dangerous scale. That is more than all the countries on Earth emit in a single year. And, with global climate negotiators focused on limiting a rapid increase in emissions, installing cool roofs and pavements would offset more than 10 years of emissions growth, even without slashing industrial pollution.

Akbari's paper, "Global Cooling: Increasing Worldwide Urban Albedos to Offset CO2," to be published in the journal Climatic Change, was written with his colleague Surabi Menon and UC Berkeley physicist Arthur Rosenfeld, a member of the California Energy Commission. All three have been associated with the laboratory's Heat Island Group, which has published extensive research on how roofs and pavement raise urban temperatures. Akbari and Rosenfeld said they will mount an effort to persuade the United Nations to organize major cities to alter their roofing and pavement. "I call it win-win-win," Akbari said. "First, a cooler environment not only saves energy but improves comfort. Second, cooling a city by a few degrees dramatically reduces smog. And the third win is offsetting global warming."

A roof is the covering on the uppermost part of a building. A roof protects the building and its contents from the effects of weather. Structures that require roofs range from a letter box to a cathedral or stadium, dwellings being the most numerous. In most countries a roof protects primarily against rain. Depending upon the nature of the building, the roof may also protect against heat, against sunlight, against cold and against wind. Other types of structure, for example, a garden conservatory, might use roofing that protects against cold, wind and rain but admits light. A verandah may be roofed with material that protects against sunlight but admits the other elements. The characteristics of a roof are dependent upon the purpose of the building that it covers, the available roofing materials and the local traditions of construction and wider concepts of architectural design and practice and may also be governed by local or national legislation.

The elements in the design of a roof are: the material, the construction, the durability.

The **material** of a roof may range from banana leaves, wheaten straw or seagrass to lamininated glass, aluminium sheeting and precast concrete. In many parts of the world ceramic tiles have been the predominant roofing material for centuries.
The **construction** of a roof is determined by its method of support and how the underneath space is bridged and whether or not the roof is *pitched*. The *pitch* is the angle at which the roof rises from its lowest to highest point. Most domestic architecture, except in very dry regions, has roofs that are sloped, or *pitched*. The pitch is partly dependent upon stylistic factors, but has more to do with practicalities. Some types of roofing, for example thatch, require a steep pitch in order to be waterproof and durable. Other types of roofing, for example pantiles, are unstable on a steeply pitched roof but provide excellent weather protection at a relatively low angle. In regions where there is little rain, an almost flat roof with a slight run-off provides adequate protection against an occasional downpour.
The **durability** of a roof is a matter of concern because the roof is often the least accessible part of a building for purposes of repair and renewal, while its damage or destruction can have serious effects.

There are two parts to a roof, its supporting structure and its outer skin, or uppermost weatherproof layer. In a minority of buildings, the outer layer is also a self-supporting structure. The roof structure is generally supported upon walls, although some building styles, for example, geodesic and A-frame, blur the distinction between wall and roof.

Support

The supporting structure of a roof usually comprises beams that are long and of strong, fairly rigid material such as timber, and since the mid 19th century, cast iron or steel. In countries that use bamboo extensively, the flexibility of the material causes a distinctive curving line to the roof, characteristic of Oriental architecture. Timber lends itself to a great variety of roof shapes. Moreover, because timber can be worked in a variety of ways, the timber structure can fulfil an aesthetic as well as practical function, when left exposed to view. Stone lintels have been used to support roofs since prehistoric times, but cannot bridge large distances. The stone arch came into extensive use in the Ancient Roman period and in variant forms could be used to span spaces up to 140 feet across. The stone arch or vault, with or without ribs, dominated the roof structures of major architectural works for about 2,000 years, only giving way to iron beams with the Industrial Revolution and the designing of such buildings as Paxton's Crystal Palace, completed 1851. With continual improvements in steel girders, these became the major structural support for large roofs, and eventually for ordinary houses as well. Another form of girder is the reinforced concrete beam, in which metal rods are encased in concrete, giving it greater strength under tension.

Outer layer

This part of the roof shows great variation dependent upon availability of material. In simple vernacular architecture, roofing material is often vegetation, such as thatches of different materials, the most durable being sea grass with a life of perhaps 40 years. In areas with an abundance of timber, wooden shingles are used, while in some countries the bark of certain trees can be peeled off in thick, heavy sheets and used for roofing. The 20th century saw the manufacture of composition shingles which can last from a thin 20-year shingle to the thickest which are limited lifetime shingles, the cost depending on the thickness and durability of the shingle. When a layer of shingles wears out, they are usually stripped, along with the underlay and roofing nails, allowing a new layer to be installed. An alternative method is to install another layer directly over the worn layer. While this method is faster, it does not allow the roof sheathing to be inspected and water damage, often associated with worn shingles, to be repaired. Having multiple layers of old shingles under a new layer causes roofing nails to be located further from the sheathing, weakening their hold. The greatest concern with this method is that the weight of the extra material could exceed the dead load capacity of the roof structure and cause collapse.
Slate is an ideal, and durable material, while in the Swiss Alps roofs are made from huge slabs of stone, several inches thick. The slate roof is often considered the best type of roofing. A slate roof may last 75 to 150 years, and even longer. However, slate roofs are often expensive to install – in the USA, for example, a

slate roof may have the same cost as the rest of the house. Often, the first part of a slate roof to fail is the fixing nails; they corrode, allowing the slates to slip. In the UK, this condition is known as "nail sickness". Because of this problem, fixing nails made of stainless steel or copper are recommended, and even these must be protected from the weather.

Roofs made of cut turf (known as Green roofs) have good insulating properties and are increasingly encouraged as a way of "greening" the Earth. Adobe roofs are roofs of clay, mixed with binding material such as straw or animal hair, and plastered on lathes to form a flat or gently sloped roof, usually in areas of low rainfall.

In areas where clay is plentiful, roofs of baked tiles have been the major form of roof. The casting and firing of roof tiles is an industry that is often associated with brickworks. While the shape and colour of tiles was once regionally distinctive, now tiles of many shapes and colours are produced commercially, to suit the taste of the purchaser. Sheet metal in the form of copper and lead has also been used for many hundreds of years. Both are expensive but durable, the vast copper roof of Chartres Cathedral, oxidised to a pale green colour, having been in place for hundreds of years. Lead, which is sometimes used for church roofs, was most commonly used as flashing in valleys and around chimneys on domestic roofs, particularly those of slate. Copper was used for the same purpose.

In the 19th century, iron, electroplated with zinc to improve its resistance to rust, became a light-weight, easily-transported, waterproofing material. While its insulating properties were poor, its low cost and easy application made it the most accessible commercial roofing, world wide. Since then, many types of metal roofing have been developed. Steel shingle or standing-seam roofs last about 50 years or more depending on both the method of installation and the moisture barrier (underlayment) used and are between the cost of shingle roofs and slate roofs. In the 20th century a large number of roofing materials were developed, including roofs based on bitumen (already used in previous centuries), on rubber and on a range of synthetics such as thermoplastic and on fibreglass.

Insulation

Some roofing materials, particularly those of natural fibrous material, such as thatch, have excellent insulating properties. For those that do not, extra insulation is often installed under the outer layer. In developed countries, the majority of dwellings have a ceiling installed under the structural member of the roof. The purpose is to insulate against heat and cold, noise, dirt and often from the droppings and lice of birds who frequently choose roofs as nesting places.

Other forms of insulation are felt or plastic sheeting, sometimes with a reflective surface, installed directly below the tiles or other material; synthetic foam batting laid above the ceiling and recycled paper products and other such materials that can be inserted or sprayed into roof cavities.

So called Cool roofs are becoming increasingly popular, and in some cases are mandated by local codes. Cool roofs are defined as roofs with both high reflectivity and high emissivity.

Drainage

The primary job of most roofs is to keep out water. The large area of a roof repels a lot of water, which must be directed in some suitable way, so that it does not cause damage or inconvenience.

Flat roof of adobe dwellings generally have a very slight slope. In a Middle Eastern country, where the roof may be used for recreation, it is often walled, and drainage holes must be provided to stop water from pooling and seeping through the porous roofing material.

Similar problems, although on a very much larger scale, confront the builders of modern commercial properties which often have flat roofs. Because of the very large nature of such roofs, it is essential that the outer skin is of a highly impermiable material. Most industrial and commercial structures have conventional roofs of low pitch.

In general, the pitch of the roof is proportional to the amount of precipitation. Houses in areas of low rainfall frequently have roofs of low pitch while those in areas of high rainfall and snow, have steep roofs. There are regional building styles which contradict this trend, the stone roofs of the Alpine chalets being usually of gentler incline. These buildings tend to accumulate a large amount of snow on them, which is seen as a factor in their insulation. The pitch of the roof is in part determined by the roofing material available, a pitch of 3/12 or greater slope generally being covered with asphalt shingles, wood shake, corrugated steel, slate or tile.

The water repelled by the roof during a rainstorm is potentially damaging to the building that the roof protects. If it runs down the walls, it may seep into the mortar or through panels. If it lies around the foundations it may cause seepage to the interior, rising damp or dry rot. For this reason most buildings have a system in place to protect the walls of a building from most of the roof water. Overhanging eaves are commonly employed for this purpose. Most modern roofs and many old ones have systems of valleys, gutters, waterspouts, waterheads and drainpipes to remove the water from the vicinity of the building. In many parts of the world, roofwater is collected and stored for domestic use. Areas prone to heavy snow benefit from a steel roof because their smooth surfaces shed the weight of snow more easily and resist the force of wind better than a wood shingle or a concrete tile roof.

In materials science, the **strength** of a material refers to the material's ability to resist an applied force. A material's strength is a function of engineering processes, and scientists employ a variety of strengthening mechanisms to alter the strength of a material. These mechanisms include work hardening, solid solution strengthening, precipitation hardening and grain boundary strengthening and can be quantified and qualitatively explained. However, strengthening mechanisms are accompanied by the caveat that mechanical properties of the material may degenerate in an attempt to make the material stronger. For example, in grain boundary strengthening, although yield strength is maximized with decreasing grain size, ultimately, very small grain sizes make the material brittle. In general, the yield strength of a material is an adequate indicator of the material's mechanical strength. Considered in tandem with the fact that the yield strength is the parameter that predicts plastic deformation in the material, one can make informed decisions on how to increase the strength of a material depending its microstructural properties and the desired end effect. Strength is considered in terms of compressive strength, tensile strength, and shear strength, namely the limit states of compressive stress, tensile stress and shear stress, respectively. The effects of dynamic loading is probably the most important practical part of the strength of materials, especially the problem of fatigue. Repeated loading often initiates brittle cracks, which grow slowly until failure occurs.

However, the term **strength of materials** most often refers to various methods of calculating stresses in structural members, such as beams, columns and shafts, when the equations of equilibrium are not sufficient to solve the problem. In such problems, known as statically indeterminate problems, the elastic or plastic resistance of the material to deformation must be considered when calculating stresses. In this sense, the word ``strength'' could well be replaced by ``stiffness'', but the usage goes back to at least 1930 and is not likely to go away any time soon.

Stress terms

Uniaxial stress is expressed by

$$\sigma = \frac{F}{A},$$

where F is the force (N) acting on an area A (m^2). The area can be the undeformed area or the deformed area, depending on whether engineering stress or true stress is used.

- *Compressive stress* (or compression) is the stress state when the material (compression member) tends to compact. A simple case of compression is the uniaxial compression induced by the action of opposite, pushing forces. Compressive strength for materials is generally higher than that of tensile stress, but geometry is very important in the analysis, as compressive stress can lead to buckling.

- *Tensile stress* is a loading that tends to produce stretching of a material by the application of axially directed *pulling* forces. Any material which falls into the "elastic" category can generally tolerate mild tensile stresses while materials such as ceramics and brittle alloys are very succeptable to failure under the same conditions. If a material is stressed beyond its limits, it will fail. The failure mode, either ductile or brittle, is based mostly on the microstructure of the material. Some Steel alloys are examples of materials with high tensile strength.

- *Shear stress* is caused when a force is applied to produce a *sliding* failure of a material along a plane that is parallel to the direction of the applied force. An example is cutting paper with scissors.

Strength terms

- *Yield strength* is the lowest stress that gives permanent deformation in a material. In some materials, like aluminium alloys, the point of yielding is hard to define, thus it is usually given as the stress required to cause 0.2% plastic strain.

- *Compressive strength* is a limit state of compressive stress that leads to compressive failure in the manner of ductile failure (infinite theoretical yield) or in the manner of brittle failure (rupture as the result of crack propagation, or sliding along a weak plane - see shear strength).

- *Tensile strength* or *ultimate tensile strength* is a limit state of tensile stress thats leads to tensile failure in the manner of ductile failure (yield as the first stage of failure, some hardening in the second stage and break after a possible "neck" formation) or in the manner of brittle failure (sudden breaking in two or more pieces with a low stress state). Tensile strength can be given as either true stress or engineering stress.

- *Fatigue strength* is a measure of the strength of a material or a component under cyclic loading, and is usually more difficult to assess than the static strength measures. Fatigue strength is given as stress amplitude or stress range ($\Delta\sigma = \sigma_{max} - \sigma_{min}$), usually at zero mean stress, along with the number of cycles to failure.

- *Impact strength*, it is the capability of the material in withstanding by the suddenly applied loads in terms of energy. Often measured with the Izod impact strength test or Charpy impact test, both of which measure the impact energy required to fracture a sample.

Strain (deformation) terms

- *Deformation* of the material is the change in geometry when stress is applied (in the form of force loading, gravitational field, acceleration, thermal expansion, etc.). Deformation is expressed by the displacement field of the material.

- *Strain* or *reduced deformation* is a mathematical term to express the trend of the deformation change among the material field. For uniaxial loading - displacements of a specimen (for example a bar element) it is expressed as the quotient of the displacement and the length of the specimen. For 3D displacement fields it is expressed as derivatives of displacement functions in terms of a second order tensor (with 6 independent elements).

- *Deflection* is a term to describe the magnitude to which a structural element bends under a load.

Stress-strain relations

- *Elasticity* is the ability of a material to return to its previous shape after stress is released. In many materials, the relation between applied stress and the resulting strain is directly proportional (up to a certain limit), and a graph representing those two quantities is a straight line.

The slope of this line is known as Young's Modulus, or the "Modulus of Elasticity." The Modulus of Elasticity can be used to determine stress-strain relationships in the linear-elastic portion of the stress-strain curve. The linear-elastic region is taken to be between 0 and 0.2% strain, and is defined as the region of strain in which no yielding (permanent deformation) occurs.

- *Plasticity* or plastic deformation is the opposite of elastic deformation and is accepted as unrecoverable strain. Plastic deformation is retained even after the relaxation of the applied stress. Most materials in the linear-elastic category are usually capable of plastic deformation. Brittle materials, like ceramics, do not experience any plastic deformation and will fracture under relatively low stress. Materials such as metals usually experience a small amount of plastic deformation before failure while soft or ductile polymers will plasticly deform much more.

Consider the difference between a fresh carrot and chewed bubble gum. The carrot will stretch very little before breaking, but nevertheless will still stretch. The chewed bubble gum, on the other hand, will plasticly deform enormously before finally breaking.