

**Learning Materials (Th.3)**  
**ADVANCED CONSTRUCTION TECHNIQUES & EQUIPMENT**  
**Semester- 6<sup>th</sup>**  
**KIIT Polytechnic, Bhubaneswar**

**Chapter 1: Advanced construction materials**

**(A) Plastic as Construction Material**

Plastic is a general name given to a wide range of synthetic materials that are based on polymers. The construction industry uses plastic for a wide range of applications because of its versatility, strength-to-weight ratio, durability, corrosion resistance, and so on.

Plastic can be manufactured into forms such as; pipes, cables, coverings, panels, films, sheets and so on; and can be formed or expanded to create low-density materials; and be dissolved in solvents.

Some of these plastics main uses in the construction industry are,

- Cladding panels.
- Cables
- Pipes and gutters.
- Windows and doors.
- Shuttering
- Wall linings
- Floor covering
- Ceiling panels.
- Roof coverings.
- Sinks, basins, baths, and showers.

: The advantages of using plastic in construction are that it is lightweight yet strong which makes it easier to transport and shift around sites. It is also resistant to rot and corrosion and has strong weather ability due to it being capable of achieving tight seals.

: The disadvantages of plastic are that it has a high embodied energy content and a low modulus of elasticity, meaning that it is generally unsuitable for load-bearing applications.

## **PROPERTIES: -**

: Typically, construction professionals select plastic materials based on the following criteria:

1. Durability
2. Cost effectiveness
3. Recycling
4. Energy saving
5. Safety
6. Easy to install

## Use of Plastics in Different Aspects of the Construction Industry

### 1.Flooring

Plastic materials like polyvinyl chloride (PVC) and polyethylene are used to make flooring less prone to wear and tear. It also decreases the sound pollution level and can be cleaned easily.

### 2.Roofing

To protect the outer surface of the roof from damage, two layers of different plastic materials are required. The upper part is made of colored thermoplastic olefin or vinyl while the lower part consists of polyurethane foam which consumes less energy and keeps the interior of a house cooler.

### 3.Insulation

Polyurethane spray is frequently used for insulation when constructing green or low energy buildings. Rigid polyurethane foam is known for its high thermal resistance which promotes temperature consistency. Polyurethane foam is also popular because it is lightweight, chemical resistant, and flame retardant. Due to its closed cell nature, polyurethane insulation performs as an air barrier, resulting in significant energy savings.

### 4.Wall

A structural insulated panel (SIP) is a sandwich of expanded polystyrene amidst two slim layers of oriented strand board. This type of pre-fab, composite wall board can be transferred to the work place easily for a particular task and provide good support to columns and other associated essentials during renovation.

### 5.Pipes

Commonly made up of polyvinyl chloride (PVC), CPVC, acrylonitrile butadiene styrene (ABS) or polyethylene, plastic pipes are flexible and very light in weight, making them easy to install. All of these plastic materials are also highly chemical and water resistant, making them suitable for many extreme environments.

### 6.Windows

Polycarbonate is used to manufacture building windows. This plastic material is strong, clear and very light in weight. Polycarbonate windows are considered more burglar-proof than regular glass windows. Two plastics materials, vinyl and fiberglass, are used commonly in the production of window frames. Fiberglass is extremely strong while vinyl is quite durable and also inexpensive.

#### 7.Doors

Some construction projects use doors made from a stiff polyurethane foam core with a fiber reinforced plastic (FRP) coating. The sandwich structure of these doors makes them incredibly strong.

#### **TYPES:-**

##### **PVC:-**

Polyvinyl chloride (PVC), a synthetic resin made from the polymerization of vinyl chloride. Second only to polyethylene among the plastics in production and consumption, PVC is used in an enormous range of domestic and industrial products, from raincoats and shower curtains to window frames and indoor plumbing. A lightweight, rigid plastic in its pure form, it is also manufactured in a flexible "plasticized" form.

##### **RPVC:-**

RPVC means Rigid PolyVinyl Chloride which comes from PVC. Polyvinyl chloride (PVC), also known as vinyl, is a common plastic polymer (a polymer being a large molecule). It comes in two basic forms: flexible and rigid (RPVC). RPVC is used in construction (especially pipes), packaging etc. RPVC Pipes with high impact strength & load bearing capacity!

##### **HDPE:-**

High density polyethylene (HDPE) piping systems have been used for municipal and industrial water applications for over 50 years. Within Building & Construction Division, HDPE pipes are used for ground source geothermal applications, also known as earth energy or geoexchange systems.

##### **FRP:-**

Fibre-reinforced plastic (FRP) (also called fiber-reinforced polymer).FRP bars are used as internal reinforcement for concrete structures. FRP bars, sheets, and strips are used for strengthening of various structures constructed from concrete, masonry, timber, and even steel. Fibre reinforced polymers are used in the construction of special structures requiring electrical neutrality.

##### **GRP:-**

GRP stands for 'Glass Reinforced Plastic' a material made from a polyester resin, which is reinforced by chopped strand mat glass fibres to form a GRP laminate. It is a very popular composite material to use because not only is it very strong but also surprisingly light.

#### **Coloured Plastic Sheets:-**

Plastic film is a thin continuous polymeric material. Thicker plastic material is often called a "sheet". Plastic sheets are generally low cost, easy to manufacture, durable, strong for their weight, electrically and thermally insulative, and resistant to shock, corrosion, chemicals, and water.

## **(B) FIBER AS A CONSTRUCTION MATERIAL**

- Fiber or fibers is a class of material which are having continuous filaments or having discrete elongated pieces similar to the length of thread.
- Fibers are very important in the biology of plants and animals for holding tissue together. They are often used in the manufacture of other materials.
- Fibers can be spun into filaments or string or rope which can be used as a component of composite material or matted into sheets so as to make the products like paper or felt.
- Fibers are inorganic or organic, natural or synthetic. Synthetic fibers can be produced very cheaply and in large amounts as compared to natural fibers. Rayon and nylon are organic synthetic fibers.
- Burlap is a coarse jute or hemp which is a natural fiber. Hessian is a jute fabric. Silk and cotton are produced from natural fibers.
- Glass wool, lead wool and asbestos are mineral fibers of which glass wool and lead wool are synthetic fibers.
- Steel fiber, carbon fiber and glass fiber are the new and recent trends used in the construction work.

### **General Uses of Fibers**

- Fibers are used for packing and making fabrics and felts.
- Glass wool made of very fine fibers of glass is used for making acid-proof and fire-proof fabrics.
- Glass wool is also used as a packing material for heat, sound and electric insulation. It is commonly used in a solar water system.
- Lead wool prepared from fine fibers of lead is used in water pipe joints to stop leakage of water. Natural jute fibers are extensively used in plumbing work to stop leakage of water.

### **Types of Fibers :**

There are mainly three types of fibers which are commonly used as a construction materials.

#### **1. Steel fiber**

Steel fiber are made from the cold drawn steel wire with low content of carbon or stainless steel wire. They are manufactured in various types such as hooked steel fibers, undulated or

flat steel fibers according to the need required in the construction project. These fibers are used in the construction for concrete reinforcement. Steel fiber reinforced concrete is less expensive than hand tied re-bar shape, dimensions and length of the fiber are more important because it increases the tensile strength of the concrete.

Steel fibers can only be used on surfaces so as to avoid corrosion and rust stains. Fiber-reinforced normal concrete is mostly used for on-ground floors and pavements and also used for the construction parts such as beams, pillars, foundation etc.

### **Properties of Steel Fibers**

- It increases the tensile strength of concrete.
- It is more tough and hard.
- It avoids corrosion and rust stains.
- They are more elastic in nature.
- Steel fibers are available with standards as ASTM 820/96, ASTM C 1116/95 and DIN 1045.
- It has a tensile strength of 1.100 N/mm<sup>2</sup>.
- They are available in the shapes like flat, hooked and undulated.

### **Applications of Steel Fibers on Field**

- Steel fibers are highly used in tunnel lining work.
- It is mostly used in the construction of airport runways and highway pavements.
- Most commonly used in precast concrete so as to increase the tensile strength.
- They are used in shotcrete.
- Used in the construction of parking.
- It is used in anti-seismic buildings.

## **2. Carbon fibers**

Carbon fiber is a material consisting of extremely thin fibers about 0.005 mm to 0.010 mm in diameter and mostly composed of carbon atoms. Carbon fiber is alternately called graphite fiber. The carbon atoms are bonded together in microscopic crystals which are more or less aligned parallel to the long axis of the fiber. The crystal alignment makes size of fiber more strong. Number of carbon fibers are twisted together so as to form a Yarn which can be used as it exist or woven into a fabric. It can be combined with a plastic resin and wound or moulded to form composite materials like carbon fiber reinforced plastic to provide a high strength to weight ratio of the materials. The atomic structure of carbon fiber is similar to that of graphite consisting of sheets of carbon atoms arranged in a regular hexagonal pattern. Carbon fibers shows the number of properties very close to the properties of asbestos. Each carbon filament thread

is a bundle of many thousand carbon filaments. A single such filament is a thin tube with a diameter of 5-8  $\mu\text{m}$  (i.e. 5-8 micrometres) and consists of almost exclusively of carbon.

### **Properties of Carbon Fibers**

- It has a high tensile strength, low weight and low thermal expansion.
- They are rigid materials which are resistant to stretching and compression.
- It is chemically inert or unreactive materials.
- They are resistant to corrosion.
- Fibers contained about 85% carbon has excellent flexural strength.

### **Application of Carbon Fibers**

- Carbon fiber is mostly used to reinforce composite material.
- Reinforced Carbon-Carbon (RCC) consists of carbon fiber-reinforced graphite and is used structurally in high temperature applications.
- It increases the tensile as well as compressive strength of concrete.
- Due to high tensile strength, low weight and low thermal expansion it makes the carbon fiber very popular in aerospace, military and motorsports along with other competition sports.
- Carbon fiber is extensively used in the bicycle industry, especially for high-performance racing bikes.
- It is also used in some tennis rackets.
- It is now being used in musical instruments for its weather resilience and ability to recreate the tone of guitars.

### **3. Glass fibers**

It is also called as fiber glass. Glass fiber is the material made from extremely fine fibers of glass. It was invented in 1938 by Russell Games Slayter. In 1893, Edward Drummond Libbey exhibited a dress at the World's Columbian Exposition incorporating glass fibers with the diameter and texture of silk fibers. This was first worn by the well known and popular stage actress of the time Georgia Cayvan. There are two main types of glass fiber manufacture and two main types of glass fiber product. First fiber is made either from a direct melt process or a marble remelt process. Both start with the raw materials in solid form. It is almost always made of platinum alloyed with rhodium for better durability. Platinum is used because the glass melt has a natural affinity for wetting it. The fresh and thin fibers are more strong because the thinner fibers are more ductile.

### **Properties of Glass Fibers**

- It has high ratio of surface area to weight.
- They have good thermal insulation.
- It has a good tensile strength but has no strength against compression.
- Compressive strength is weak but can be increased by reinforcing it with plastic.

- When the glass fiber is reinforced with plastic, then reinforced material can resist both compressive and tensile forces as well.
- It is resistant to chemical attack. However, if its surface area is increased, then it makes them more susceptible to chemical attack.
- They are corrosion resistant.

### **Application of Glass Fibers**

- Corrugated fiber glass panels are widely used for outdoor canopy or greenhouse construction.
- It is used as a reinforcing agent for many polymer products like FRP and GRP which uses tubs, pipes for drinking water and 'sewers, office plant containers and flat roof systems etc.
- It is reinforced with plastic material so as to increase tensile strength.
- Uses of regular fiber glass are mats, insulation, reinforcement sound absorption, heat resistance fabrics, corrosion resistant fabrics and high strength fabrics.
- Glass fiber reinforced plastics are used in the house building market for the production of roofing laminate, door surrounds, over-door canopies, window canopies and dormers, chimneys, coping system, heads with keystone and sill etc.
- The reinforced glass fiber with polymer and plastic is commonly used in fire water systems, cooling water systems, drinking water systems, sewage systems, waste water systems, gas system etc.

### **(B) ARTIFICIAL TIMBER**

Reduction of moisture content along with improving some qualities before the use of woods is called seasoning of timber. By seasoning, generally, the moisture is reduced to about 15% where new cut woods bear about 50%.

#### **Reasons for Seasoning**

Seasoning of timber is done to fulfill some specific requirement. Followings are the reasons to perform timber seasoning.

- 1.To change and improve the properties of wood.
- 2.To make a correct percentage of shrinking of woods.
- 3.To make a confident use of woods.
- 4.To reduce the adverse behaviour of woods.

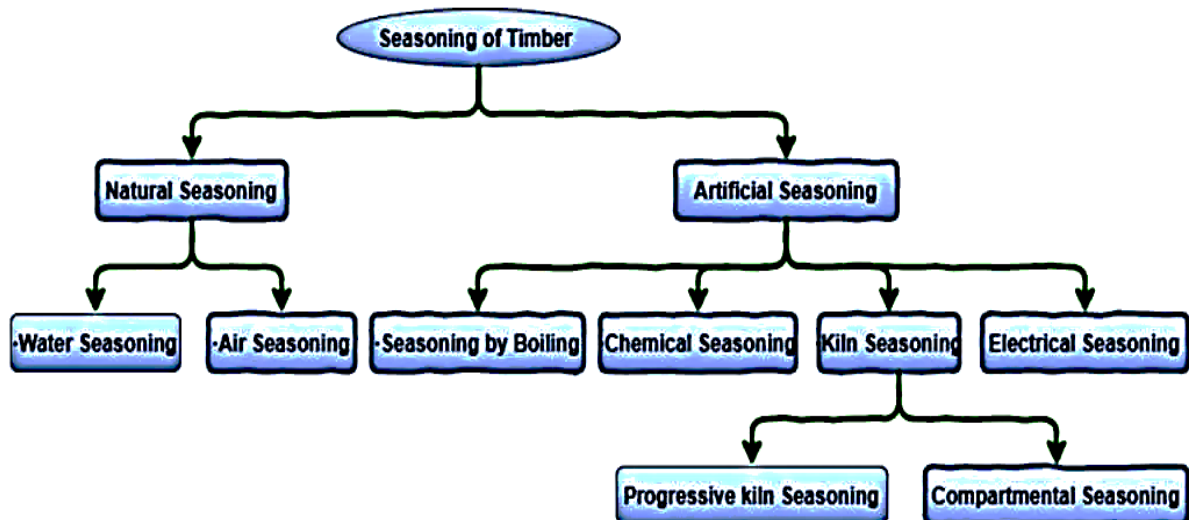
## Methods of Seasoning of Timber

There are mainly two methods of seasoning of timber. These are:

A) Natural Seasoning

B) Artificial Seasoning

Following tree diagram can be used to illustrate all the methods of timber seasoning.



### Natural Seasoning

Seasoning of woods or timbers using natural elements is called natural seasoning. eg. water and air seasoning.

#### a. Water seasoning

Removal of wood sap immersing logs into water flow is called water seasoning. It is carried out on the banks of the river while thicker ends are kept towards upstream. After that, the logs are allowed to dry. Disadvantage: It is time consuming such as 2 to 4 weeks generally.

#### b. Air seasoning

Exposing the woods to air for seasoning. At first, a platform is required that is built on the ground at 300mm height above the ground.

Secondly, the arrangement of woods in layers. Air circulation is maintained between logs because it helps to reduce the moisture which is important for seasoning. The environment for this need to maintain some conditions. A clean, shady, dry, cool place is preferred. Sometimes logs are coated by the impermeable substance to reduce extreme moisture. To improve the quality oil coating,



thick paint coating is maintained. To prevent fungal infection logs are treated with petrol or gasoline.

**Advantage:**

- Good quality of seasoned wood.
- A large amount is convenient in this process.
- Well-seasoned timber is formed.

**Disadvantage:**

- It's a slow process.

**Artificial Seasoning**

**a. Seasoning by Boiling**

Seasoning by boiling wood logs in hot water is called seasoning by boiling. Drying is done after proper boiling. For a large amount of wood, it is done in an enclosed place where hot steam is passed.

**Advantages**

- It takes a short amount of time. Generally, 3-4 hours is good enough. Develops the strength and elasticity.

**Disadvantages**

- It is serviceable basically for a small quantity of wood, not convenient for a large amount. The cost is high.

**b. Chemical seasoning**

Reduction of moisture using salt solution is called chemical seasoning. After the absorption of water by the solution logs are let to dry.

**Advantage**

- It increases the strength of the timber.
- It is less time-consuming.

**Disadvantage**

- Chemical reagents can sometimes reduce strength.
- It can cause a problem in gluing or finishing or corrosion while using.

**c. Kiln seasoning**

Seasoning of wood by using a large chamber or oven where there is a good process for the circulation of hot air.

**Advantage**

Most effective and economic seasoning.

Kiln seasoning can be done by 2 processes such as: -

- Progressive kiln Seasoning: Wood log is entered through the kiln and the temperature and humidity differentials are maintained through the length of the kiln to maintain proper drying.
- Compartmental Seasoning: It's maintained by enclosed container or buildings. Advantage: It accelerates the process because external energy is used.

#### **d. Electrical seasoning**

Dry wood is non-conductor of electricity while green timber is a conductor, so, can pass alternating current. Thus, in this method alternating current is used for the resistance of timber against electricity is measured at every interval of time. When the required resistance is reached seasoning, process is stopped because resistance of timber increases by reducing moisture content in it. It is also called as rapid seasoning and it is uneconomical.

#### **(C) Miscellaneous Materials.**

A category of asbestos-containing building material comprised mostly of nonfriable asbestos products and materials, such as ceiling tiles, floor tiles, roofing felt, transit pipes and panels, exterior siding, fabrics, and sheetrock systems.

- **Acoustics Material**

When the sound intensity is more, then it gives the great trouble or nuisance to the particular area like auditorium, cinema hall, studio, recreation centre, entertainment hall, college reading hall. Hence it is very important to make that area or room to be sound proof by using a suitable material called as 'Acoustic material'. It is measured in decibels (db).

#### **Properties of Acoustic Material**

- Sound energy is captured and adsorbed.
- It has a low reflection and high absorption of sound.
- Higher density improves the sound absorption efficiency at lower frequencies.
- Higher density material help to maintain a low flammability performance. Hence acoustic material should have higher density.
- It controls the sound and noise levels from machinery and other sources for environmental amelioration and regulatory compliance.
- Acoustic material reduces the energy of sound waves as they pass through.
- It suppresses echoes, reverberation, resonance and reflection.

#### **Uses of Acoustic Material**

- Acoustic materials can be used for noise reduction and noise absorption. It makes the sound more audible which is clear to listen without any disturbances.
- 2. It suppresses echoes, reverberation, reflection and resonance.
- Important specifications for noise reduction and noise absorption products include noise attenuation and noise reduction coefficient.
- 4. A vinyl acoustic barrier blocks controls airborne noise (street traffic, voices, music) from passing through a wall ceiling or floor.

- 5. Acoustic foam and acoustic ceiling tiles absorb sound so as to minimize echo and reverberation within a room.
- 6. Sound proof doors and windows are designed to reduce the transmission of sound.
- A sound proof wall (treated by a accurate material) can incorporate sound proofing and acoustic materials to meet desired sound transmission class (STC) values.

### Wall cladding



Wall cladding is a type of decorative covering intended to make a wall look like it is made of a different sort of material than it actually is. Some of the most common examples are on the outside of buildings, but cladding can also be an artistic element in interior decorating.

The most common types of cladding are Stone Cladding, Brick Cladding, Timber Cladding, Metal Cladding, Concrete Cladding, Glass Cladding.

### Plasterboard



Plasterboard is a panel made of calcium sulphate dihydrate (gypsum) usually pressed between a facer and a backer. It is used to make interior walls and ceilings. This 'Drywall' construction became popular as a quicker alternative to traditional lath application.

## Microsilica



Micro silica or silica fume is an excellent admixture for concrete as it leads to better engineering properties. It reduces thermal cracking, improves durability, and increases strength. Silica fume concrete has a number of construction applications.

## Artificial Sand



Artificial sand, also called crushed sand or mechanical sand, refers to rocks, mine tailings or industrial waste granules with a particle size of less than 4.75 mm, which are processed by mechanical crushing and sieving, but does not include soft and weathered granules.

## Bonding Agents



Bonding agents are natural, compounded or synthetic materials used to enhance the joining of individual members of a structure without employing mechanical fasteners. The most commonly used types of bonding agents are generally made from natural rubber, synthetic rubber or from any

other organic polymers. The polymers include polyvinyl chloride, polyvinyl acetate etc. With the addition of bonding agent in repair mortar or concrete, the reduced water-cement ratio can be adopted for the same workability, thereby reducing drying shrinkage.

### **Adhesive**



Construction adhesive is a general-purpose adhesive used for attaching drywall, tile, moulding, and fixtures to walls, ceilings, and floors. It is most commonly available in tubes intended for use.