TOPIC 8

Polymers

Polymers

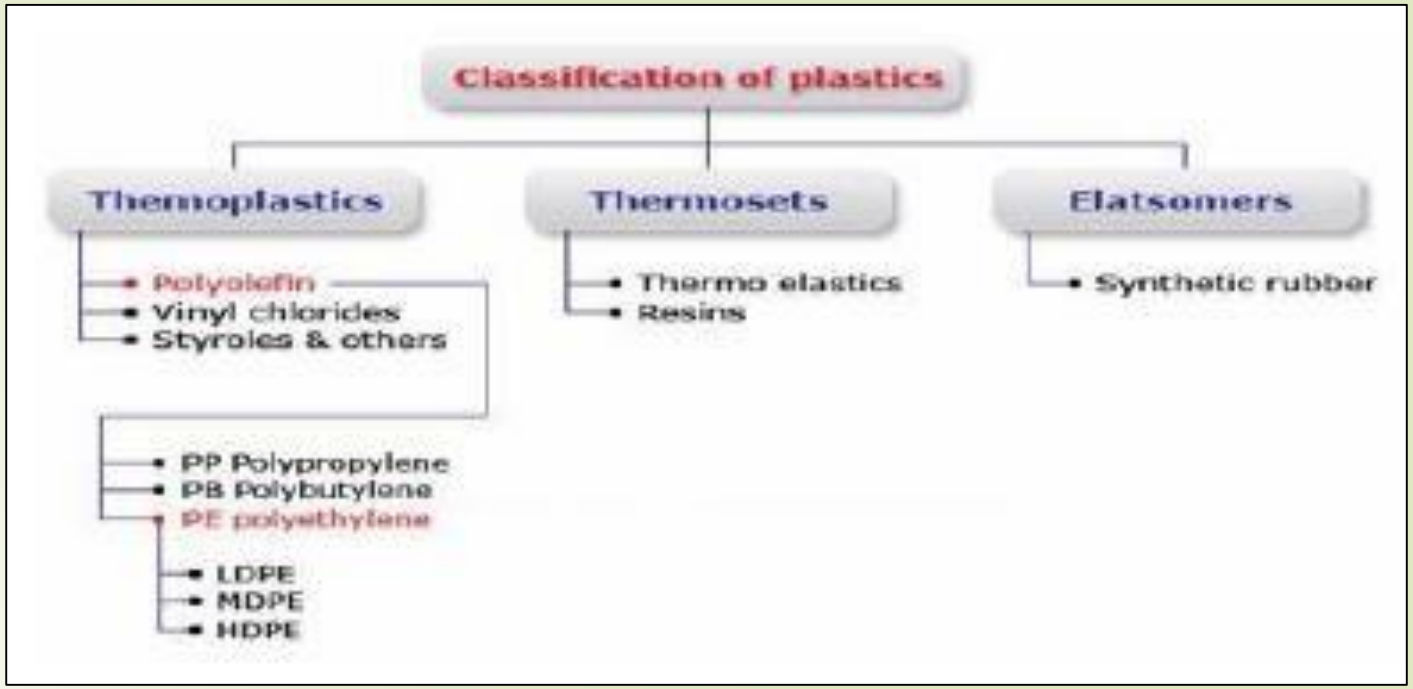
- Polymers are defined as macromolecules composed of one or more chemical units that are repeated throughout a chain.
- These materials are based on carbon and possess the following properties;
  - They have a low density usually around that of water
  - They are plastic i.e. become soft and malleable when they are heated
  - They are inert i.e.do not absorb water, are not affected by DILUTE ACIDS and ALKALIS
  - They are readily moulded or shaped
  - They are good thermal insulators
  - Several types of products can be formed from them
- Limitations include:
  - Low stiffness
  - Low resistance to heat and susceptible to fire
  - High thermal movement. Also many types not degradable after disposal

Polymers

- There are a wide range of materials whose composition is based on polymers i.e.
  - All plastic products,
  - paints,
  - coatings,
  - adhesives, etc.
- Depending on how they are linked or joined (chemical bonds or intermolecular forces) and on the arrangement of the different chains that forms the polymer, the resulting polymeric materials can be classified as:
  1. Thermoplastics – which can be softened by heating and then remoulded through Injection moulding in which the softened polymer is injected under pressure into a heated mould. This process is suitable when forming irregularly shaped products Extrusion in which the softened material is forced through a die to give long lengths of constant section e.g. pipes

Polymers

2. **Elastomers** which are polymers with very high strain capability e.g. natural rubber used for bridge bearings, silicone rubber used for sealants
3. **Thermosets** e.g., Epoxy Resins for heavy duty flooring (high resistance to chemicals), polyurethanes for making weather proof varnish



Polymers

Paints

- These are surface coatings, generally suitable for site use and marketed in liquid form. They are used to;
  - protect the underlying surface by exclusion of atmosphere, moisture, fungi and insects
  - provide a decorative and easily maintainable surface
  - provide light and heat reflecting properties
  - give special effects, for example, inhibitive paints for protection of metals and condensation-resisting paints
- Paints are made by mixing and blending three main components:
  1. **The pigments** - Pigments are finely ground inorganic or organic powders which provide colour, opacity, film cohesion and sometimes corrosion inhibition.
  2. **The binder** - Binders are usually resins or oils but can be inorganic compounds such as soluble silicates. The binder is the film forming component in the paint.
  3. **The solvent** - Solvents are used to dissolve the binder and to facilitate application at the paint. Solvents are usually organic liquids or water.

Polymers

Paints

- There are usually 3 key stages in painting namely;
  i. PRIMER,
  ii. UNDERCOAT and
  iii. the FINISHING COAT.
- **Primer** – The function of the primer key role is to provide protection against corrosion and dampness and to provide a good key for the remaining coats.
- **Undercoat** – The function of undercoat is to provide good opaqueness or hiding power together with a smooth surface which will provide a good key for the finishing coats. Undercoats usually contain large quantities of pigment to assure the required opaqueness
- **The Finishing coat** – Which provides a durable layer of the required color and texture. The finish coat provides the required appearance and surface resistance of the system. Depending on the conditions of exposure, it must also provide the first line of defense against weather and sunlight, open exposure, and condensation

Polymers

Types of Paints

1. **Oil Paints -** Widely used paints for general purposes including painting of wood and metals. On long periods of exposure to the sunlight these paints become brittle resulting in the development of cracks (especially when applies to structures with high levels of movement such as timber). The brushes and other equipment used for their application need to be washed with organic solvents such as thinners (or kerosene) which may prove hazardous.
2. **Emulsion Paints** (PVA – Polyvinyl Acetate) - An emulsion paint is a type of paint that is generally used for interior decoration (and exterior decoration too!) with an emphasis on painting walls and ceilings. Unlike gloss paints that give a very glossy finish these paints tend to give a matt effect and are often used to cover large areas. Emulsion paints are water based and are made up from a mix of synthetic particles, a colour pigment and water. These paints work so well on walls and ceiling because they are easier to apply than many other paints and they have a longer life in terms of their colour hold and their durability. You can also wash down an emulsioned wall or ceiling to clean it without damaging the paint and it is easier to clean up spills and drips with this kind of paint than with other paints due to its water base. The paint brushes can be easily washed with water after use.
3. **Bituminous Paints** - A low-cost paint containing asphalt (a bituminous mixture that contains substantial amounts of fine material in the form of sand and filler together with the binder which form a stiff paste like product) or coal tar, a thinner, and drying oils; used to waterproof (or damp-proof) the concrete and to protect piping

Composite Materials

Composite materials.

- These materials usually combine the best properties of their constituents and frequently exhibit qualities that do not even exist in their constituents
- Composite materials have improved properties in:
  - Strength
  - stiffness,
  - specific weight,
  - corrosion and wear resistance,

Other properties include attractiveness, fatigue life, temperature susceptibility, thermal insulation, thermal conductivity, and acoustical insulation

Fiber Reinforced Polymers

- Examples of composite materials very useful for civil engineers include **Fiber Reinforced Polymer (Fiber Reinforced Polymers (FRP**))
- It is strong, stiff, and corrosion resistant, and can be used to make concrete reinforcing rebars to eliminate the corrosion problem of steel rebars
- These combinations of properties are formidable and typically cannot be found in a conventional material.
- FRP is a matrix consisting of carbon or glass fibers encapsulated in a polymer or resin
- The resin provides stability, shear strength and bonding of the FRP to the substrate
- Examples of FRP products include:
  - Sheets and Fabrics
  - Pre-cured laminates
  - Grids

Products from FRP

FRP Bars

FRP Grid

Stay-In-Place Forms

Benefits of FRP

1. High Strength/weight ratio
2. Orientated strength
3. Design flexibility
4. Lightweight
5. Corrosion resistance
6. Low maintenance/long-term durability
7. Large part size possible
8. Tailored aesthetic appearance
9. Dimensional stability
10. Low thermal conductivity
11. Low installed costs

FRP Composite Constituents

1. Resins (Polymers) – To transfer stress between reinforcing fibers and to protect them from mechanical and environmental damage.
2. Reinforcements – Carry load along the length of the fiber proverb strength and or stiffness in one direction.
3. Fillers
4. Additives

Thank You!!!