ENGINEERING MATERIALS FOR SUSTAINABILITY- CV0424

UNIT – 3

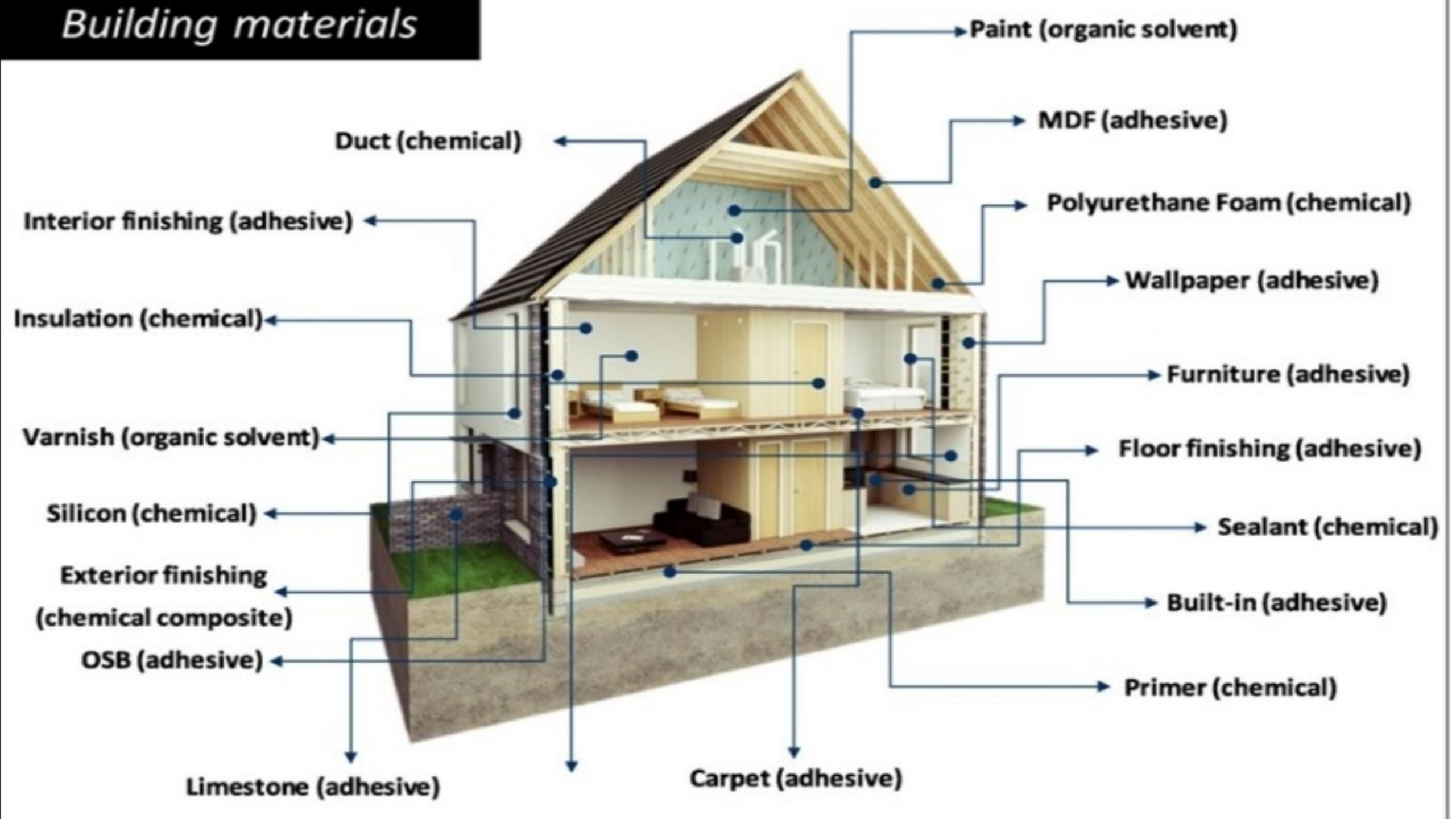
DEPARTMENT OF CIVIL ENGINEERING

SEALANTS,HEALTH HAZARDS OF BUILDING MATERIALS AND EMISSION MODELS

INTRODUCTION

- BUILDING MATERIALS
- SEALANTS
- STRUCTURAL ELASTOMERS
- WATER PROOFING SURFACE TREATMENTS
- PRODUCTS BASED ON SYNTHETIC BINDERS
- HEALTH HAZARDS FROM BUILDING MATERIALS

Building materials



SEALANTS

- **Sealants are similar to adhesives except that they fill gaps and not bond the substrate.**
- **Fillers are added to get good gap filling properties and slump resistance against flow.**
- **Desirable properties:**

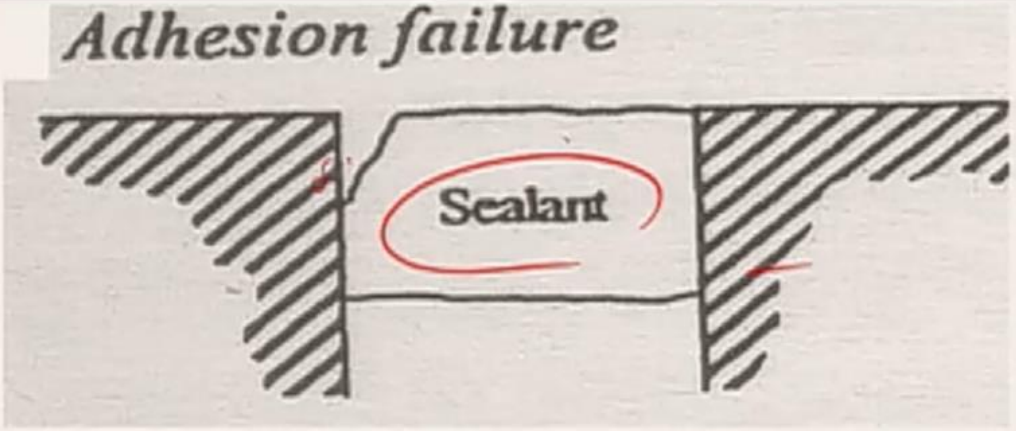
Flow 3mm maximum

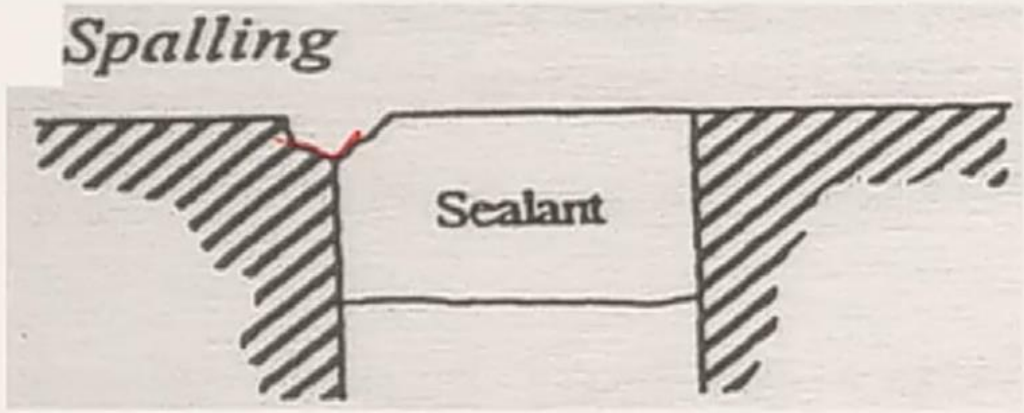
Elastic recovery (resilience)

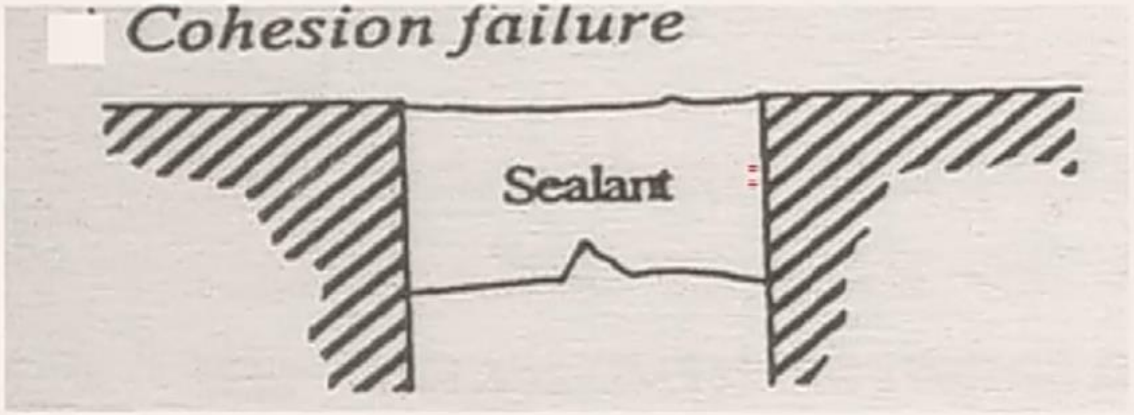
MATERIALS USED AS SEALANTS

- **Pitch, tar, waxes & Bitumen i.e. natural thermoplastics have been used from almost pre-historic tme.**
- **Glazing putties made of linseed oil and other drying natural resins(13-15%) and fillers such as chalk (85-87%) were used 17^{th} century.**
- **But cannot accomaodate large movement. Hence synthetic polymers as sealant, such as poly-sulphides , poly-urethanes , acrylic latex.**

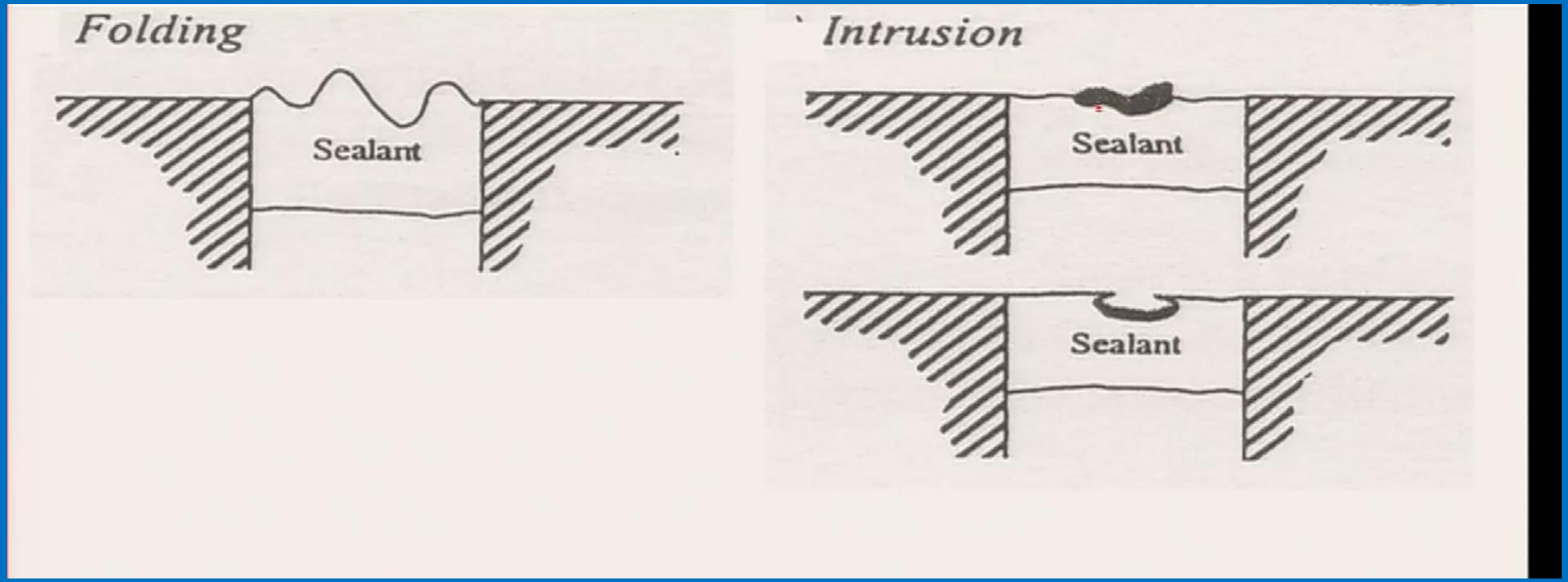
FAILURE OF SEALANTS







FAILURE OF SEALANTS



SERVICE LIFE OF SEALANTS

SEALANT TYPE	OLEO RESIN	BITUMEN	RUBBER/ BITUMEN	BUTYL RUBBER	ACRYLIC RESIN	FLEXIBLE EPOXY
SERVICE LIFE	10	10	10	10	15	20

SEALANT TYPE	POLYSULPHIDE	POLYURETHANE	SILICONE
SERVICE LIFE	20	20	20

STRUCTURAL ELASTOMERS

- **Vibration isolation, noise control bearings in bridges requires resilient materials.**
- **Carbon loaded natural rubber, reinforced with steel plate, laminated blocks synthetic rubber(poly chloroprene) with cork particles with nylon fiber reinforcement are used as vibraton isolation pad.**
- **Neoprene bearings, PTFE are common for bridges.**

WATER PROOFING SURFACE TREATMENTS

- **Coatings include polyesters, epoxies, acrylics, etc.**
- **Alkoxy-silanes are monomeric organo-silicon compound containing carbon, hydrogen, oxygen and silicon atoms can penetrate deep in to porous material & on curing can bond with substrate.**
- **Large number of Alkoxy-silanes joined together forms sioxane (M-R-H_2SiO_3) & several siloxane together forms silicone.**

WATER PROOFING SURFACE TREATMENTS

- **Silicone resin dissolved in solvent is used in pore lining treatment, solvent evaporates & deposits water repellent silicone; can also be obtained through poly-merisation of siloxanes.**
- **Pore blocking treatment are liquid silicates or silicofluoride that reacts with lime forms C-S-H gel & insoluble calcium silicofluoride.**

PRODUCTS BASED ON SYNTHETIC BINDERS

- **Epoxy resins are the bi-components reacting in ambient temperature.**
- **Chemically are poly-ethers formed by reaction between poly-epoxy(base) and hardener (polyamides) comprising of active hydrogen atom.**
- **Products is highly cross-linked and reaction is exothermic ; high mechanical properties, chemical resistance, strong bonding to usual material, good dimensional stability.**

PRODUCTS BASED ON SYNTHETIC BINDERS

- **Poly-urethanes used in non-structural repairs, paints coating etc.**
- **Surface repair product against crazing, bug-holes and spalling of concrete, includes polymer modified system.**
- **Structural bonding of reinforcement/metals/composites or bonding of concrete epoxy resin formulations are used.**

HEALTH HAZARD FROM BUILDING MATERIALS

- **70-80% time spent indoor.**
- **Radiation: exposure to ionizing radiation is correlated to increased rate of lung cancer.**

  (UPPER LIMIT:200-300 Bq/m^3)
- **Chemical carcinogen and endocrine disruptors from chemicals: lung cancer**
- **Formaldehydes: other diseases**
- **Volatile organic compounds (VOC), toluene, xylene, styrene ,1,2,4 trimethylbenzene are associated with asthma.**

HEALTH HAZARD FROM BUILDING MATERIALS

- **Formaldehydes are highly water soluble, hence absorbed in the respiratory tracts once inhaled.**
- **After absorption is distributed rapidly in the entire body and undergoes rapid transformation within body. Then excreted out via exhalation in or renal excretion in 1-1.5 minutes.**
- **This leads to several affects on the body system.**
- **Sources are paints, sealants, etc. e.g. urea formaldehyde, phenol-formaldehyde. VOC can be present in the indoor from carpet etc.**

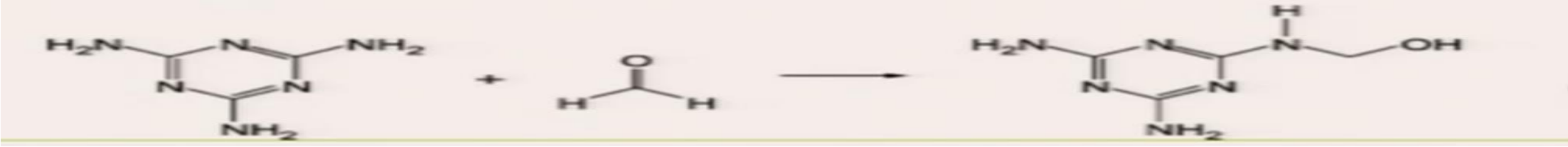
UREA FORMALDEHYDE RESIN

- **Urea-formaldehyde resin is used in many building application and is the source of formaldehyde.**

- **Polymer formed from Urea and Formaldehyde**

  i.e., $H_2N\text{-}CO\text{-}NH_2$ & HCHO

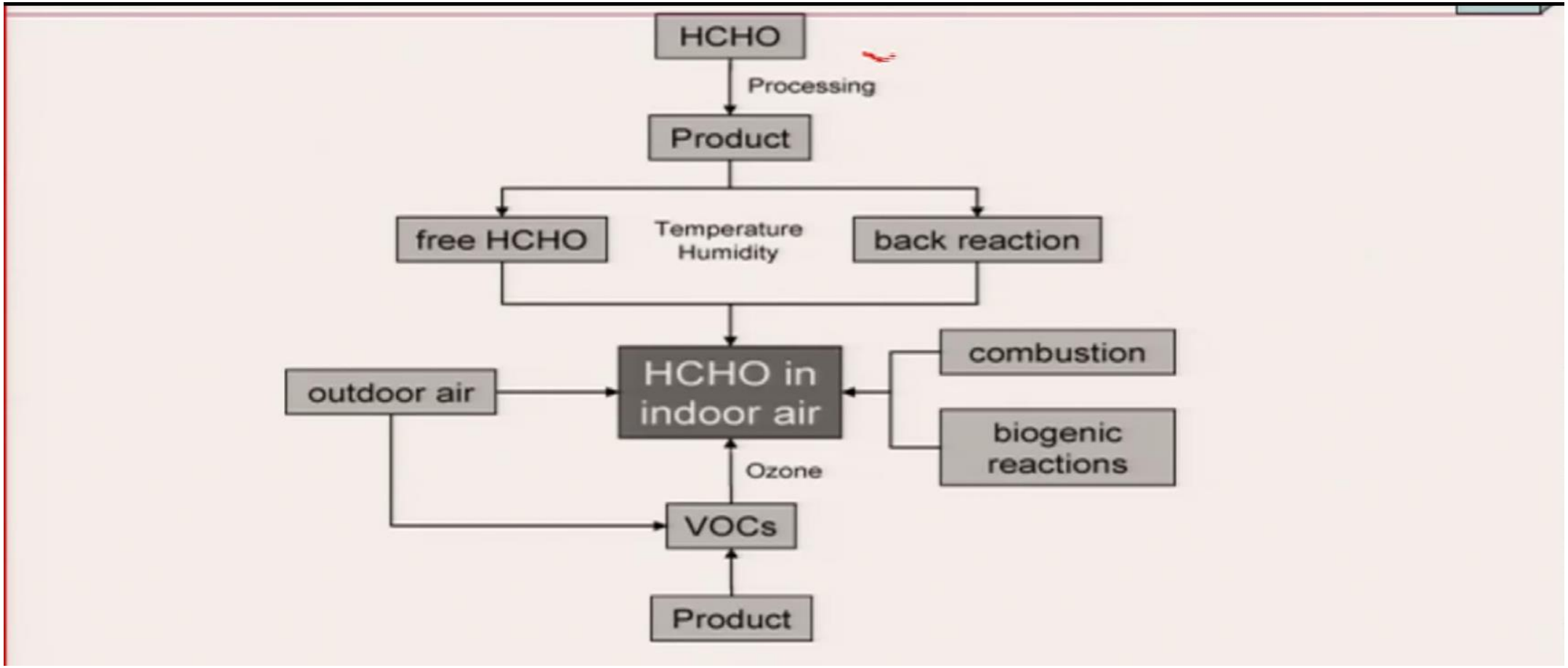
- **Melamine-urea-formaldehyde (MUF) is also used as adhesive.**



SOURCES OF HEALTH HAZARD MATERIALS

- **Used in cork products in floor, particle boards, plywood etc.**
- **In insulation material UF foam, mineral wool**
- **In paper products , coating, paints, textiles.**
- **In cleaning and caring products.**
- **In Disinfectants and Preservatives.**
- **In cosmetics**

CHART FOR HEALTH HAZARD OF BUILDING MATERIALS



POTENTIAL INDOOR SOURCES

- **Wood based materials.**
- **Flooring materials**
- **Insulations**
- **Coating, paints and textiles.**
- **Cleaning and caring products**
- **Disinfectants and preservatives.**

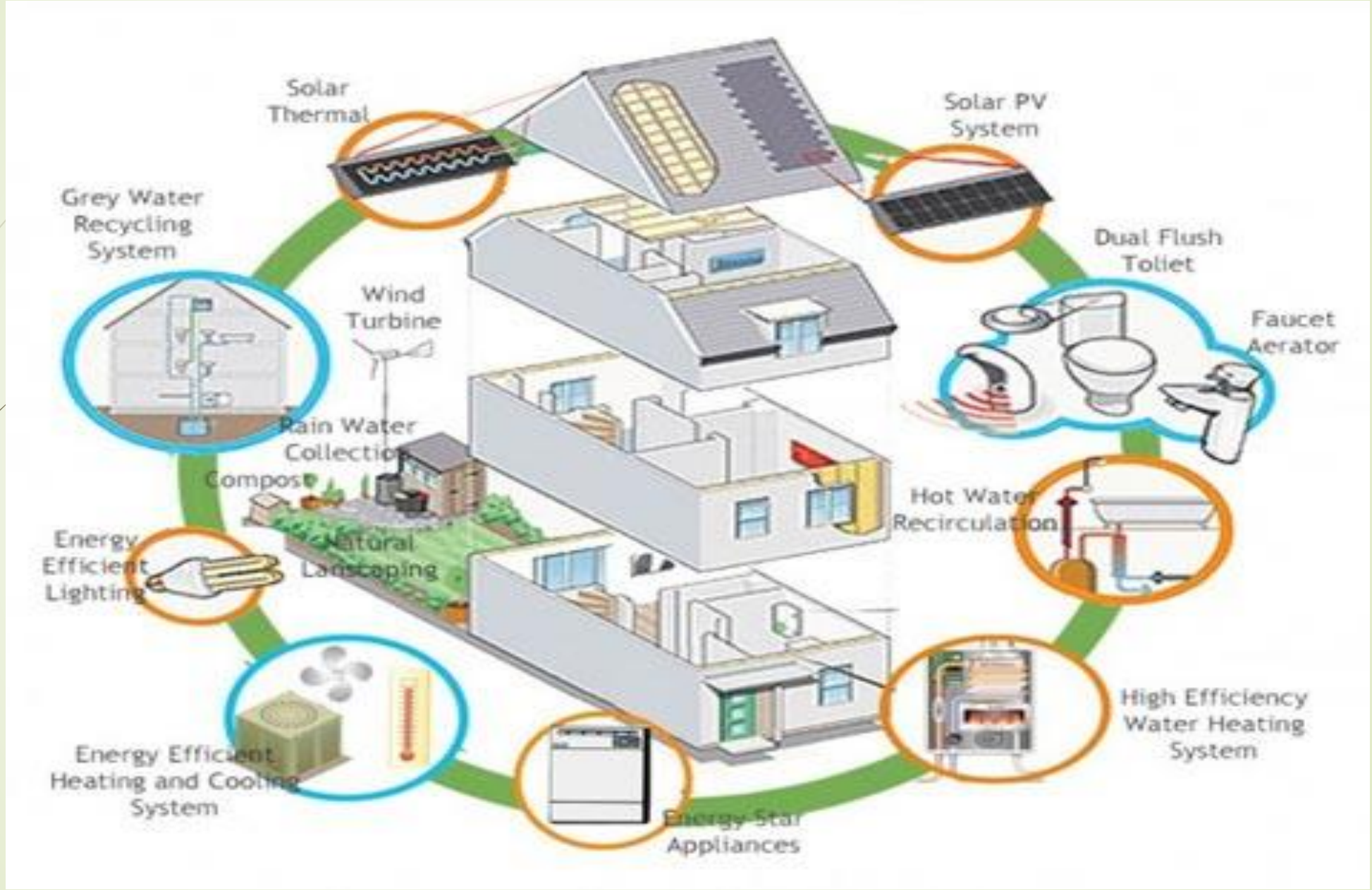
Energy Efficient Design Of Buildings &
Design Optimization Of Building

Net Zero Building

- A net zero energy building is a building with greatly reduced energy needs through efficiency gains such that the balance of energy can be supplied using renewable technologies.
- Energy from : Low cost, Locally available, Non polluting, Renewable, etc.

Net Zero Building Check List

- Windows & Doors
- Ventilator
- Exterior Shading Device
- Solar Panel
- Solar Heater
- Rain Water Harvesting
- Horizontal Wind Turbine
- Energy Star Application


Solar Thermal
Solar PV System
Grey Water Recycling System
Dual Flush Toilet
Wind Turbine
Faucet Aerator
Rain Water Collection
Compost
Hot Water Recirculation
Natural Landscaping
Energy Efficient Lighting
High Efficiency Water Heating System
Energy Efficient Heating and Cooling System
Energy Star Appliances

Types

- **Net Zero Site Energy** : The amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building
- **Net Zero Source Energy :** The energy used to transport the energy to the building. This type accounts for energy losses during electricity generation and transmission.
- **Net Zero Energy Emission :** The carbon emissions generated from on-site or off-site fossil fuel use are balanced by the amount of on-site renewable energy production.
- **Net Zero Energy Cost :** The cost of purchasing energy is balanced by income from sales of electricity to the grid of electricity generated on-site.

Important Parameters For Building Design

- Most important of all the parameters are
  1. Wall Material
  2. Roof Material
  3. Type of Glass
  4. Shape (Dimension)
  5. Orientation
- Design process involves selecting the right combination of design parameters with minimum energy consumption (Air-Conditioned Building) or maximum thermal comfort (Non-Air-Conditioned Building) in the building

Backward & Forward Analysis

- Backward analysis is an analysis to determine properties of the inputs of a program from properties or context of the outputs.
- Such a method restricts the design scope as well as the quality of results considerably, because it implies that the building is already designed.
- Forward analysis is the analysis which determines properties of the output of a program from properties of the inputs.
- It is done by testing a number of design alternatives by computing the thermal performance of each one.

- **Backward analysis**

  1.Tack very long time for best solution and tedious process

  2.Not necessarily give best solution

  3.Cannot give global optimum solution

  4.Till date most of the work on building thermal analysis is based on the backward analysis

- **Forward analysis**

  1.Can give best solution

  2.can give global optimum solution

  3.Can be done through optimization process

Thermal Design Of Building

- In thermal design process, large number of choices of design parameters are available
- For greater degree of energy performance, it is required to optimize and design the best or nearly best option within these choices
- Therefore, \there is need to find out an optimal solution through thermal optimal design process with the knowledge of level of decision variable
- In building optimization process, various parameters involve, some are qualitative or discrete
- optimization procedure should incorporate all the qualitative and discrete variable
- Genetic algorithm can work on this situation, because it works on coding of parameter instead of directly working upon it

Broad Objective Of Research

- To develop a simple and systematic thermal optimation modle based on GA:
    1. To minimize heating/cooling load of air-conditioned building
    2. To maximize inside thermal comfort in non-air-conditioned building
- To incorporate all the design parameters simultaneously
- To improve the quality of result and save time

Optimization (Forward Analysis)

- Optimization is the procedure or procedures used to make a system or design as effective or functional as possible
- Usually contains some elements: decision variable, objective function and constrains
- Variable that is directly under the control of the operations analysis is called decision variable
- Objective function is a mathematical expression of objectives, and is expressed as function of decision variables
- Although not mandatory, it is usual to find the mathematical expression of the limitation on the fulfillment of the mathematical expression of the limitation on the fulfillment of the objectives, called constrains.

Optimization Methods

- Ideal Material Concept
- Utility Theory
- Single Function Optimization
- Classical Method
- Gradient Method
- Direct Search Method
- Genetic Algorithm