Lecture Four
Materials and examination tools

Chemical Properties of Building Materials

The properties of materials against the chemical actions or chemical combinations are termed as chemical properties. And they are

- Chemical resistance
- Corrosion resistance
- Crystallization

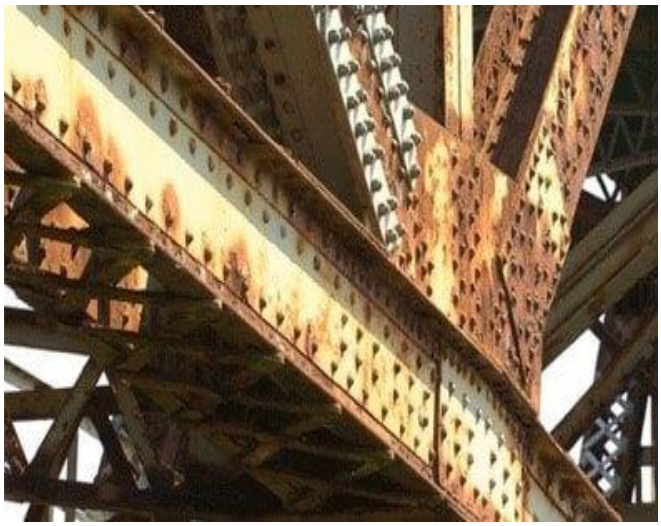
1. Chemical Resistance of Building Materials مقاومة المواد الكيمياوية

The ability of a construction materials to resist the effects by chemicals like acids, salts and alkalis is known as chemical resistance. Underground installations, constructions near sea etc. should be built with great chemical resistance.

Chemical Resistance is the ability of a material to withstand the action of acids, alkalis, sea water and gases. Natural stone materials, e.g. limestone, marble and dolomite are eroded even by weak acids, wood has low resistance to acids and alkalis, bitumen disintegrates under the action of alkali liquors.

2. Corrosion Resistance of Building Materials مقاومة التآكل

Formation of rust (iron oxide) in metals, when they are subjected to atmosphere is called as corrosion. So, the metals should be corrosive resistant. To increase the corrosion resistance proper measures should be considered. Otherwise it will damage the whole structure.



3. Crystallization of Building Materials: التبلور

Crystallization or crystallisation is the (natural or artificial) process by which a solid forms, where the atoms or molecules are highly organized into a structure known as a crystal. Some of the ways by which crystals form are precipitating from a solution, freezing, or more rarely deposition directly from a gas. Attributes of the resulting crystal depend largely on factors such as temperature, air pressure, and in the case of liquid crystals, time of fluid evaporation.

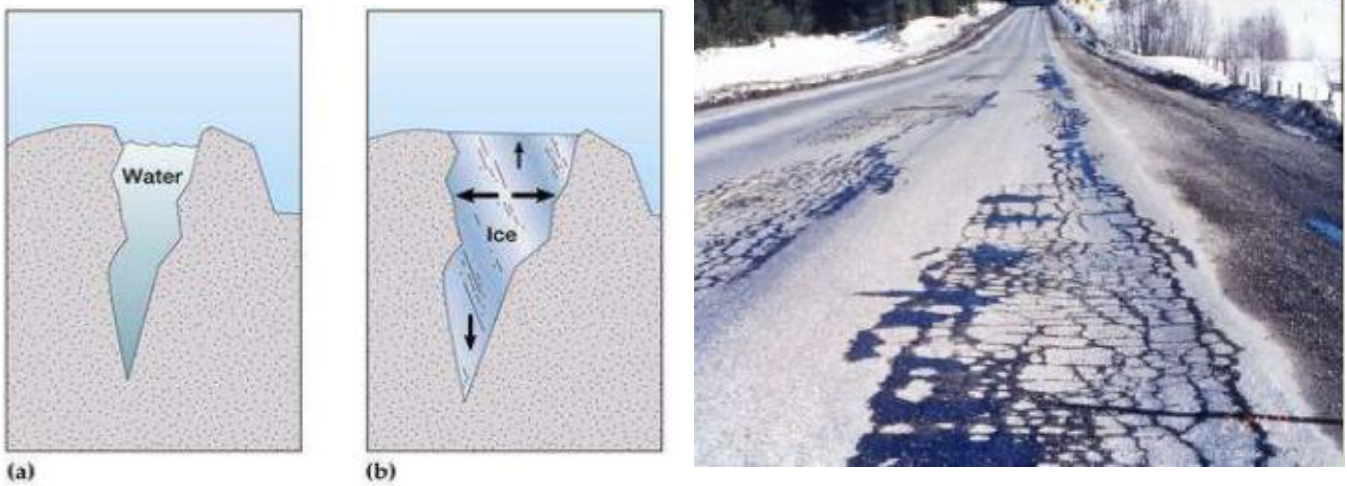
Thermal Properties of Building Materials

Thermal properties are those properties of a material which is related to its conductivity of heat. In other words, these are the properties which are exhibited by a material when the heat is passed through it. Thermal properties come under the broader topic of physical properties of materials. The thermal properties include the following:

- Frost Action
- Thermal capacity
- Thermal conductivity
- Thermal resistivity
- Specific heat

1. Frost Action in Building Materials: تأثير الانجماد

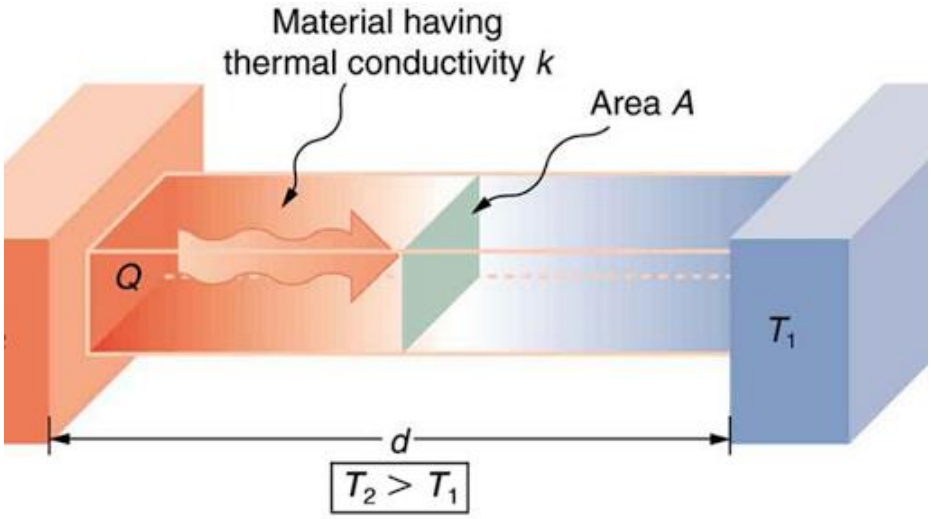
* Frost Action denotes the ability of a water saturated material to endure repeated freezing and thawing with considerable decrease of mechanical strength.
* Under such conditions the water contained by the pores increases in volume even up to 9 percent on freezing. Thus the walls of the pores experience considerable stresses and may even fail.



2. Thermal Conductivity of Building Materials:التوصيل الحرارى

*It is the property of a material which represents that how easily the heat can be conducted by material.

* The thermal conductivity of a material can be defined as “the amount of heat transmitted by unit thickness of material normal to the unit area surface in unit time when the temperature gradient across the material piece is unity in steady state condition. Its unit in SI system is watts per meter per ^{o}K.



The amount of heat transferred through unit area of specimen with unit thickness in unit time is termed as thermal conductivity. It is measured in kelvins. It depends on material structure, porosity, density and moisture content. High porous materials, moist materials have more thermal conductivity

3. Specific Heat of Building Materials:الحرارة النوعية

• Is the property of a material to absorb heat described by its specific heat.

• Thermal capacity is of concern in the calculation of thermal stability of walls of heated buildings and heating of a material, e.g. For concrete laying in winter.

• Specific heat of a material is defined as the amount of heat required to increase the temperature of unit mass of material by 1°C. It is denoted by 'S'.

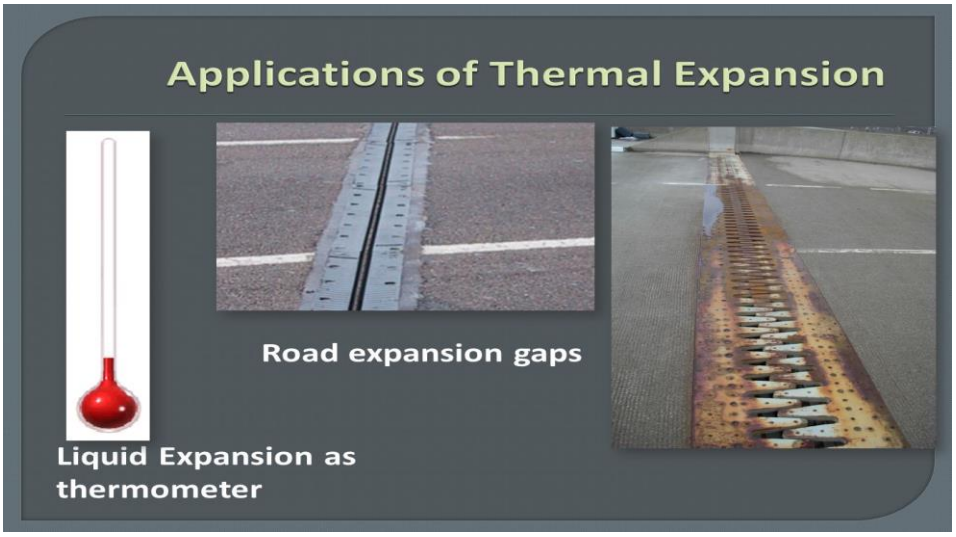
• Where, m is the mass of material in Kg. Q is the amount of heat given to material in Joule. Δt is rise in temperature. Unit of specific heat in SI system is, Joule/Kg °C.

* Specific heat is the quantity of heat required to heat 1 N of material by 1°C. Specific heat is useful when we use the material in high temperature areas. Specific heat values of some engineering materials are given below.

4. Coefficient of Thermal Expansion: معامل التمدد الحرارى

* When a material is heated, it expends, due to which its dimensions' change. Coefficient of thermal expansion, represents the expansion in material with increase of temperature.

* **Thermal expansion** is the tendency of matter to change its shape, area, and volume in response to a change in temperature. Temperature is a monotonic function of the average molecular kinetic energy of a substance. When a substance is heated, the kinetic energy of its molecules increases.



5. Thermal Capacity of Building Materials:السعة الحرارية

* Thermal capacity is the property of a material to absorb heat and it is required to design proper ventilation. It influences the thermal stability of walls. It is expressed in J/N °C and it is calculated by below formula.

Thermal capacity, $T = [H/(M(T_2 - T_1))]$

Where H = quantity of heat required to increase the temperature from T_1 to T_2

T_1 = Initial temperature

T_2 = Final temperature

M = Mass of material in N.

* thermal capacity is a physical property of matter, defined as the amount of heat to be supplied to a given mass of a material to produce a unit change in its temperature.

6. Fire Resistance of Building Materials:مقاومة الحريق

• Is the ability of a material to resist the action of high temperature without any appreciable deformation and substantial loss of strength.

• Fire resistive materials are those which char, smoulder, and ignite with difficulty when subjected to fire or high temperatures for long period but continue to burn or smoulder only in the presence of flame, e.g. Wood impregnated with fire proofing chemicals.

• Non-combustible materials neither smoulder nor char under the action of temperature.

• Some of the materials neither crack nor lose shape such as clay bricks, whereas some others like steel suffer considerable deformation under the action of high temperature.

7. Refractoriness of Building Materials:مقاومة الحريق

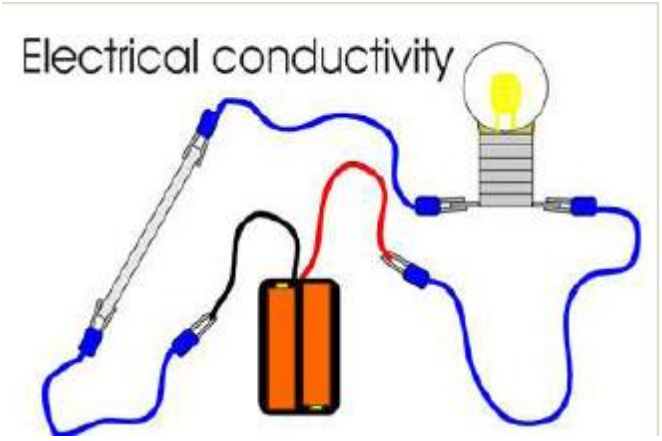
• Denotes the ability of a material to withstand prolonged action of high temperature without melting or losing shape. Materials resisting prolonged temperatures of 1580 0C or more are known as refractory.

• High-melting materials can withstand temperature from 1350 0C - 1580 0C, whereas low-melting materials withstand temperature below 1350 0C.

Electrical and Magnetic Properties of Building Materials

Magnetic Properties of Building Materials: The magnetic properties of materials like permeability, hysteresis etc. are required in the case of generators etc. iron is magnetic material and aluminum is non-magnetic material.

Electrical Properties of Building Materials: The properties of a material to conduct or to resist electricity through them are electrical properties of material. For example, wood have great electric resistance and stainless steel is a good conductor of electricity. • **It is the property of material which represents that how easily the electricity can be conducted by the material.** It is denoted by 'σ'. It is the reciprocal of resistivity of material. It unit is mho/meter.



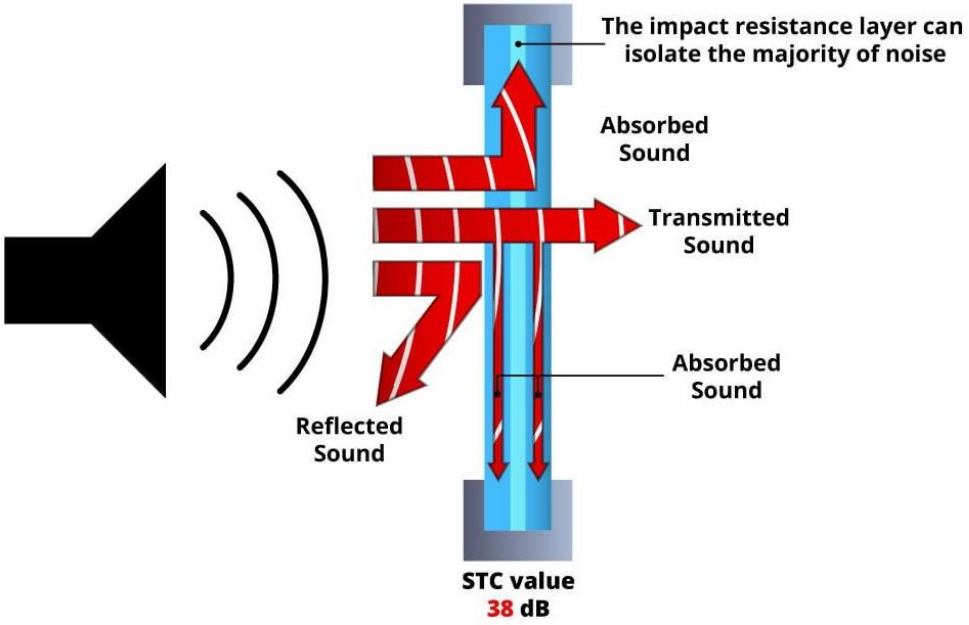
Acoustical Properties of Building Materials

Acoustical properties are those that govern how materials respond to sound waves, which are what we perceive as sound. We are all familiar with how a disturbance in a body of water will cause waves to develop and travel along the surface of the water in all directions away from the disturbance. They include the following:

- Sound Transmission
- Sound Reflection
- Sound Absorption

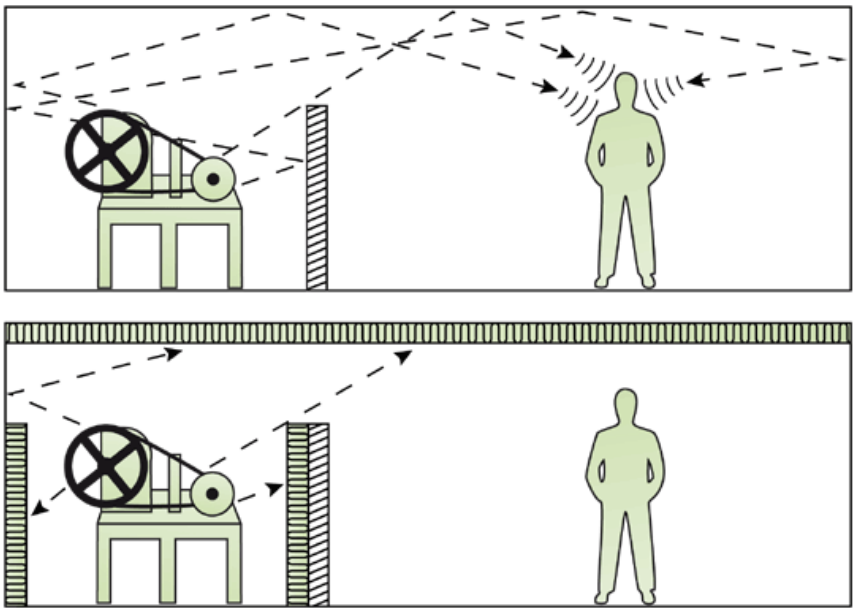
1. Sound Transmission of Building Materials: مواد ناقلة للصوت

Acoustic transmission is the transmission of sounds through and between materials, including air, wall, and musical instruments. The degree to which sound is transferred between two materials depends on how well their acoustical impedances match.



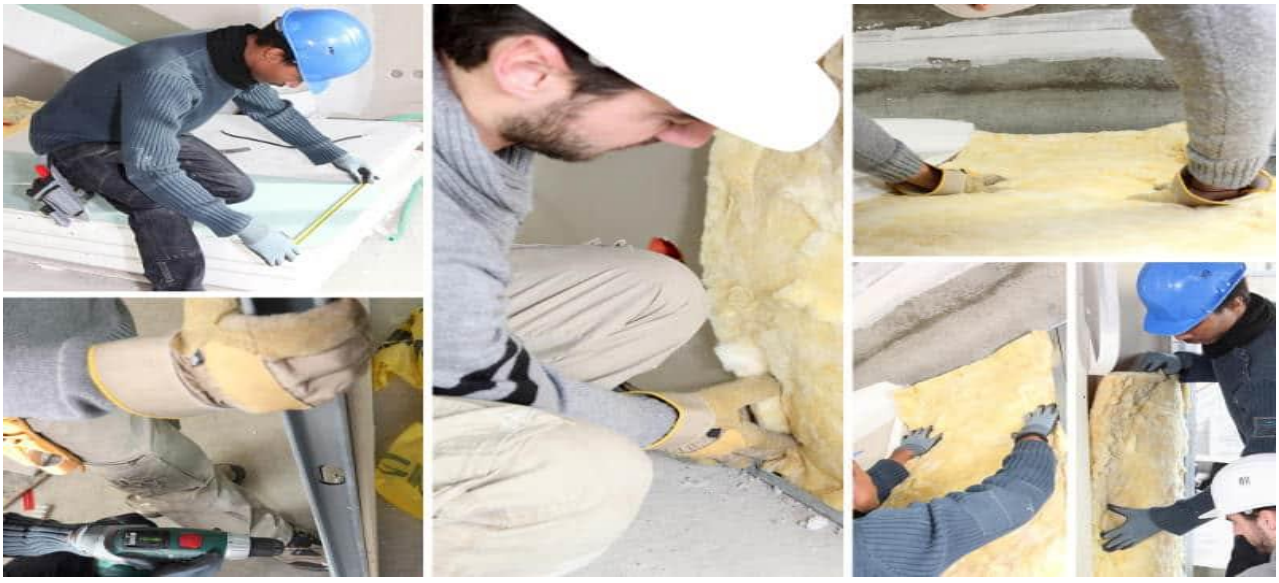
2. Sound Reflection of Building Materials: موادعاكسة للصوت

Most common **building materials** such as wood, metal and masonry have hard surfaces and thus reflect sound are loud. Thus when sound strikes the surface of a reflective barrier, some energy is transmitted through the wall but the bulk is reflected back in the general direction of the noise source. Hard, reflective, nonporous interior building surfaces such as glass, wood, plaster, brick and concrete absorb 2% to 5% of the sounds striking the surface to reflect 95% or more of the sound. Absorption coefficients are expressed as a percentage of the sound absorbed.



3. Sound Absorption of Building Materials: موادماصة للصوت

Sound absorption refers to the process by which a material, structure, or object takes in sound energy when sound waves are encountered, as opposed. Soundproofing is any means of reducing the sound pressure with respect to a specified sound source and receptor. There are several basic approaches to reducing sound: increasing the distance between source and receiver, using noise barriers to reflect or absorb the energy of the sound waves, using damping structures such as sound baffles, or using active antinoise sound generators.



Optical Properties of Building Materials

Optical Properties of Building Materials include the following:

1- Color.

2-Light Transmission.

3- Light Reflection.

Questions and Answers of Lecture Five

1-Whats the effect of Crystallization in the Durability of Building?

2-What's the important of Chemical Resistance Materials in the Durability of Building?

3-What's the effect of Corrosion Resistance Materials in the Durability of Building?

4-What's the effect of Frost Action in the Durability of Building?

5- Define the following:

(Thermal Conductivity, Specific Heat, Coefficient of Thermal Expansion, Thermal expansion, Thermal Capacity, Fire Resistance Materials, Refractoriness Materials, Sound Transmission Materials, Sound Reflection Materials, Sound Absorption Materials).