2.3.1 Properties of materials 2

Key terms relating to material degradation

Material degradation is damage that arises from the natural weathering processes that result from exposure to the outdoor environment. Here are some of its causes:

Cause	Definition
Corrosion	The gradual destruction of metals due to oxidation – this is a natural chemical reaction that occurs when metals are exposed to the environment.
Salt crystallisation	Damage resulting from stresses that are produced when natural or absorbed salts within a porous material crystalise.
Frost damage	Damage caused when moisture in the pores of a material freezes and expands.
Water damage	Damage caused by water penetration enabling a destructive process such as rotting, mould growth or the rusting of steel.
Pollution	Damage to stone and metals arising from contact with atmospheric pollutants, such as oxides of nitrogen and sulphur, which react with rainwater to produce acid rain.
Solar radiation	Damage to organic materials such as plastics and wood arising from exposure to solar UV radiation.
Vandalism	The intentional defacement or destruction of property.

Corrosion

Common types of corrosion include general attack corrosion effecting the surface of a metal structure; localised corrosion, such as surface pitting, that attacks only portions of a metal structure; and galvanic corrosion, which may occur when two different metals are located together.

Preventing corrosion requires understanding environmental conditions and metal properties so that the most suitable metal or alloy for the application can be specified. Galvanisation (the application of a zinc coating) is a common method of preventing the corrosion of steel used in construction. Stainless steel, which is an iron and chromium alloy, has a natural coating that prevents oxidation and is therefore corrosion resistant. It is also resistant to water, heat, and chemical damage.

Salt crystallisation

Salt crystallisation may result in the deterioration of porous materials, such as masonry and concrete, where excessive salt crystallisation within pores can produce internal pressures, which could result in subsequent damage, such as surface spalling.

Efflorescence often occurs in brickwork when salts escape while drying gradually. Typically, the appearance will be an unsightly powdery residue on the surface, which can be removed by pressure washing with clean water.

Frost damage

When water freezes, its volume increases by approximately 10%. This causes an increase in the internal pressure. If this pressure exceeds the tensile strength of the material, then micro-cracks occur, which become visible as a result of several freeze-thaw cycles.

Frost damage in concrete

Frost damage caused by ice volume expansion in newly placed concrete will lower its compressive strength. It is therefore essential to have a minimum curing** time at a temperature sufficiently above the freezing point of the concrete water.

***Curing refers to the initial hydration and hardening of concrete in (typically) the first three days after pouring, during which time temperature and humidity conditions must be controlled and maintained.*

Water damage

This covers various possible problems caused by water penetration, such as the rotting of wood, mould growth, rusting of steel and other metals, swelling of composite boards, and soiling of finishes.

The damage may occur over time and be relatively minor such as surface staining, or it may be instantaneous and severe such as damage arising from burst pipes or flooding.

Acid rain

Limestone and marble are used in the construction of buildings and monuments. Both are carbonates and are sensitive to acidic pollution causing concerns about damage to the stone used in construction, as well as the loss of the aesthetic details of historic buildings and monuments.

Solar radiation

The service lifetime of the plastic components in photovoltaic (PV) modules is affected by solar radiation and is a concern in the solar energy industry, where better stabilisation technologies are being investigated.