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Factors of Deterioration in Building and the Principles of Repair

Anybody who has owned property recognized that buildings are frequently subject to numerous forms of building defect, regularly in the form of dampness, wall cracks or even a water penetration to the building. Even as the cause of the building defect may be instantly noticeable in several cases, in others the cause is not so understandable. Likewise, there may be an apparent root of a defect, but this may not be the whole story, and the root of the problem may in fact lie elsewhere. An exact identification of a building defect necessitates knowledge and familiarity with the design and construction of a building combined with an indulgent of methods of scientific exploration. An accurate cause of a building defect and the form of its appearance must be understood prior to a sensible remedy can be applied. This paper will discuss on the important factors that affecting the deterioration in building and some principles of repair.

Keywords*: building deterioration, principles of repair, building diagnosis, building survey, building defects*

1. Introduction

A building defect can be defined as a material, component or finish which does not meet its accepted performance criterion. Technical knowledge and proficiency and an indulgent of building construction are necessary to accurately recognize the root of building defects and the remedial measures essential to put the defects right.

Even as the cause of the building imperfection may be straight away visible in numerous cases, in others the cause is not so comprehensible. Similarly, there may be an evident origin of a defect, but this may not be the whole story, and the root of the problem may in fact lie elsewhere [1]. Building defects can grounds range of building problems. Determining the origin of the deficiency will depend on which areas have been exaggerated. Defects in the foundation, floor, or wall can be the

direct result of soil issues, water issues, or even workmanship issues. If someone is noticing problems with foundation part, they may be experiencing water-caused issues as well as or in its place of soil issues. They require acquiring a professional evaluation of the situation, discovering what the basis cause is and receiving estimation for the repair [2].

An exact identification of a building defect necessitates knowledge and familiarity with the design and construction of a building combined with an indulgent of methods of scientific exploration [3]. An accurate cause of a building defect and the form of its appearance must be understood prior to a sensible remedy can be applied. This paper is concern to discuss on the factors that affecting the deterioration in building and some principles of repair.

2. Causes of Deterioration and Defects

According to Barry A Richardson, 1991 there are six factors that affect building deterioration if no remedial action takes place. The factors are:

2.1 Mechanical Agents

These agents impose a physical force on a building. They maybe static and permanent such as ground pressure, or static and temporary such as a snow load. Alternatively, the force can be dynamic such as wind or vibration, so the design of the structural item must include mechanical agents, though failures still happen. Besides that, it is sometimes important to remember that non-structural components, particularly plastics, may also be subject to creep and deflection due to self-weight.

2.2 Electromagnetic Agents

As far as the durability of building materials is concerned, the most important agent in this group is radiation.

a)Solar radiation

Most published information concerns total solar radiation measured as bright sunshine and total radiation.

b) Ultraviolet radiation

A large proportion of this band of radiation (290 nm-400 nm where a nm is a nanometre or one thousand millionth of a metre) is absorbed by the earth's atmosphere and so has no effect.

The radiation that penetrates the atmosphere can result in the deterioration of organic materials. Though the penetrating powers are not great, the action tends to be confined to surface layers. For example, many organic dyes are degraded by ultraviolet light, as are bituminous materials and some synthetics polymers such as those used in sealants [4].

c) The visible waveband

This spectrum of radiation (400 nm- 700 nm) is primarily experienced as heat. The total radiation received will depend on:

- Cloud cover, the proportion being the same as for solar radiation;
- The season of the year, and
- The local topography – surfaces normal to the sun such as roofs and those receive substantial reflected radiation experience the highest temperatures [4].

d) Infra-red radiation

This band of radiation (700 nm -1000 nm) is absorbed by all forms of matter, causing an increase in temperature such that the surfaces temperature will be greater than the surrounding air temperature. For a given surface texture, the colour of the surface considerably affects the absorptiveness [4].

2.3 Thermal Agents

Temperature is particularly relevant to components that are exposed to an unobstructed sky, for example roofing, cladding and external structural members. The actual temperatures reached can lead to either temporary or even permanent changes in physical or chemical properties, such as embrittlement at low temperature and accelerated oxidation at high temperatures [3].

Changes of the temperature are also relevant when assessing the consequences of thermal expansion and contraction – such as stresses within materials when changes of size are restrained and strains imposed on jointing materials when components are free to change size.

2.4 Chemical Agents

The chemical agent that is most prevalent is water. It is probably also the agent with greatest influence on the properties of materials, particularly when it is combined with extremes temperature [3]. In many instances the presence of moisture enables physical, chemical or biological reactions to take place. Examples are:

- The effect of sulphate attack on Portland cement products
- Corrosion of iron and steel products
- Electrolytic corrosion between metals
- Fungal attack of on wood products

Most materials absorb moisture to some degree. The direct effect of water alone on a material can be:

- A volumetric change
- A change in mechanical properties, for example, ordinary chipboard loses its strength and can disintegrate when it becomes saturated
- The development of twisting and turning forces happens in some unrestrained timber boards
- A change in electrical properties
- A change in thermal properties, many insulates lose their performance if they become wet
- A change in appearance

Water, in relation to buildings appears in three major forms:

- The simplest manifestation is from the water in the ground. Building failures caused by dampness from the ground are likely to be caused either by less detail in the initial design or by faulty workmanship and materials. The second manifestation of water is precipitation, which can vary from snow, hail, rain or dew [5]. The prime occurrence of water outside building is as rain. All exposed surfaces must expect to be wetted to some extent by this phenomenon. The third form of water that affects building is water vapour. Internally the major manifestation of water vapour is as condensation which is generated from within the building, often from steam-producing activities such as bathing or cooking, but even in some cases simply from the presence of a number of person's exhaling.
- Oxygen
- As far as buildings are concerned, the second most important chemical agent is probably oxygen. It is the most reactive gases that present in the air in large volumes and leads to the corrosion of metals, as well as the oxidation of paints, plastics, sealants and bituminous materials.
- Sulphates
- Sulphates are salts that are naturally present in industrial wastes, gypsum plaster, clay bricks (particularly those fired at lower temperature), flue condensates and as a solution in the groundwater in some areas. Sulphates react slowly with tricalcium aluminate (a constituent of Portland cement and hydraulic lime) forming a compound called sulphoaluminate in a net conditions. This will causes the cement mortar or renders to expand and eventually disintegrate.
- Other chemical agents
- These include gases such as carbon dioxide, sulphur dioxide and nitrogen that are all present in the atmosphere [5]. In the presence of moisture, they contribute to the formation of acids that attack susceptible materials such as unprotected metals, concrete, other cementations products and some building stones. It is important to aware that it is not only the gases themselves that can cause damage but also the existence of reactions or products of the reactions may themselves be reactive towards other materials.

2.5 Biological Agents

Biological agents can be divided into four categories;

i. Surface growths - These include bacteria, fungi, algae, lichen and mosses. They do not necessarily harm but some release acidic metabolic products which are corrosive, and other invade the surface of substrata and cause deterioration.
ii. Insect vermin - The predominant damage or deterioration to construction materials caused by insects occurs with timber and timber

based products. Although the moisture content of timber is the predominant factor, temperature is a critical agent. Infestations are inhibited by low temperature, accelerated by warmth and are occasionally destroyed by hot conditions.

iii. Animal vermin - The pests most likely to harm building materials are rats and mice, who gnaw timber, other organic substances and PVC casings to electric cables. Insulated profiled metal cladding and roofing has been damaged by birds pecking at unprotected insulation on cut sheets and of course also their by dropping debris.

iv. Plant agents - Probably the major damage to building are from tree roots disrupting foundations and penetrating underground drains. Considerable damage has occurred to buildings with shallow foundations or faulty infilling that have been erected on shrinkable clay subsoil and with trees and large shrubs nearby. Damage to building from plants has also been caused by plants growing in gutters and blocking them [5].

2.6 The Building Users

Leaving aside deliberate misuse such as vandalism, defects do occur as a result of action by the building occupants. Condensation caused by the use of propane gas and paraffin heaters is a well-known example [6].

2.7 Earth Movement

Whenever the water contents are lost from the soil, the earth or soil particle will be prone to combine together or it will be compacted. Usually clay soils are prone to make a big movement due to its natural moisture absorbance and liquid can freely flow.

The changes of moisture in earth particle could lead to changes in load especially on skyscrapers. Water in soil is usually driven out leaving the particle to combine together [6]. If the soil underneath a building is compacting or joining together, the foundation could sink until the soil is balance. This will happen after the load on the soil and the pressure it caused will eventually compress.

Other effects of earth movement are caused by big tree root that is near a building. This root will find its way through the building foundation and ultimately will cause a small movement to wall and floor element.

If a tree were cut down before laying a foundation for a building, the roots which were very strong and steady before will rot and decay. After the decaying process took place the root mass will be reduced and soil will take place of the empty space. If a foundation were built it will sink due to the movement [6].

2.8 Scope of Guidance

There is no standard guideline for repairing heritage buildings. By all means heritage building should be repaired in a very careful manner. It is important to

identify the causes before prescribing the remedies. There is no specific rules in conserving historic building but a sensitive approach, using the conservatives repair principles should always be a priority [6].

3. The Principles of Repair

3.1 The Purpose of Repair

The amount of repair should be kept to the minimum as the main intention is to slow the decaying process of the building. Extra caution must be taken in order not to alter the features of the historical building or unnecessarily disturbing historic fabric. The major aim is to ensure the strength of the structure is able to withstand the test of time.

3.2 Avoiding Unnecessary Damage

As much as we like to preserve a historic building any unnecessary alteration or replacement will be rendered useless if the changes made were very obvious. For a start the replacement of historic fabric no matter how detail it is will have an adverse effect on the building appearances and diminish the authenticity thus reducing its value.

However the elements mentioned above will decay and it is unavoidable. The rate in which the decay will take place may vary on the types of material used. Some of the materials, for instant certain type of roof require periodic complete or major replacement.

A more selective approach is required at some of these elements such as masonry, framing of walls and roofs. These items will decay slowly and in isolated areas [7].

3.3 Analyzing Historic Development

Owner or contractor involved in preserving the building need to investigate or review the historical data of the building. Usually the main criteria to look into are archaeological and architectural investigation, any record of particular structure and assessment on its historic context.

3.4 Analyzing the Causes of Defects

A deep analysis on the building historical development, detail in design of repairs and should be preceded by long term observation. This must include the condition of its material, causes and processes of the rates of decay. Without the investigation above the same problem will find a way to repeat itself [6].

3.5 Adopting Proven Techniques

Any repair that is going to take place must match or be compatible with existing material or methods of construction. This will preserve the historic value and integrity to ensure the work done has an appropriate life. If the existing

material or element failed, then exception should take place rather than neglect of maintenance because it has completed its life cycle [5]. If possible new methods or techniques shouldn't be used unless the old techniques are no longer relevant.

3.6 Preserving Originality

All heritage building repairs should be executed true to its original nature as possible without trying to hide using artificial ageing. Minimum work is sufficient when heritage building is involved to ensure minimum obstruction to its original built and design.

3.7 Restoration of Lost Features

Pinnacles, cornices, hood moulds, window tracery and members of a timber frame that may have been lost in the past. From record we could put these items back in place in the course of repair. Non structural elements also may be replace such as railings, windows, rainwater goods or shop fronts. These items may be replaced if we have sufficient data and evidence for an accurate replacement [7].

3.8 Removal of Damaging Alterations

Any renovations, alterations or additions including remedial work done on heritage building are important and to be recorded as a cumulative history of the building. Although these alterations might affect the aesthetic value of the building, the full consideration must be made in advance as to balance up the potential architectural gain and loss of historic integrity. Careful measure and record must be kept and statutory consents must be obtained in advance [4].

3.9 Safeguarding the Future

An interval of every 5 years should be considered a good routine check up in monitoring heritage building. All levels should be utilized by securing an appropriate and sympathetic use of the whole building, especially the upper floor. Any problems can be detected early on such as waterproofing problems which generally started at the highest level. Professionalism is also a good consideration in hiring a third party to maintain the building [8].

4. Conclusion

This paper has considered some of the factors affecting the deterioration in building and principles of repair. Considerate the building defects are merely a logical way of proceeding from the evidence to the cause of a defect, after which remedies can be prescribed. The more that can be found about why defects have occurred, the more can be fed back through the repair works by the professionals accountable for the conservation works. Good repair practice is central to good conservation in all countries. Repair would be the only action necessary to facilitate buildings to endure. The current reality, however is that other sorts of involvement

may be required to accommodate change. Modification of one sort or another, in addition to clear-cut repair, must sometimes be inflicted on buildings if they are to continue to be useful and wanted.

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