



## **Methods of treating and restoration of building cracks**

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### **Abstract**

Preserving architectural heritage and highlighting its value has become an important factor in the development of civilization, creating long-term ties between successive generations and preserving the spirit of the place. Today, there is a tendency to protect heritage originating from local heritage as well as to show value sites in order to convey the expertise and social customs they represent. The current research aimed to study the cracks of buildings and the methods used for treatment and restoration, in addition, to focus on methods of stone maintenance. The researcher has used the descriptive approach to achieve the objectives of the study, by reviewing several studies, articles and books that related to the current subject. The research concluded that in order to maintain sustainability, the buildings must be re-exploited and used as their non-use is damaged again. Fortunately, there are contemporary techniques used these days in the restoration of building cracks, which contributes greatly to the preservation of heritage and repair the damaged monuments. These techniques have been discussed in the current paper.

**Keywords:** Treating, Restoration, Building cracks, Stone



## **1.0 Introduction**

Restoration is the rehabilitation of old buildings that have been exposed to damage and cracks due to natural and abnormal factors, resulting in the loss of a large part of the aesthetic values that contain them. The purpose of the restoration is to preserve the structural structure of the buildings to be repaired, to reinforce these buildings through a geometric upgrade and to renovate the construction of the urban areas that require emergency intervention to stop the deterioration of the building (Nemati, 2007). In addition, to activating tourism to these sites using some buildings as tourist service centers.

The restoration usually involves renovating the building's exterior structure, roofing, improving insulation, treating floor tiles, extending a sewerage system, preparing water cycles, and establishing an electrical grid as well as treating the cracks (Dandona, 2006).

Preserving architectural heritage and highlighting its value has become an important factor in the development of civilization, creating long-term ties between successive generations and preserving the spirit of the place (Narwaria and Tiwari, 2016). Today, there is a tendency to protect heritage originating from local heritage as well as to show value sites in order to convey the expertise and social customs they represent. The current research aims to study the cracks of buildings and the methods used to treatment and restoration, in addition to focus on methods of stone maintenance.

## **2.0 Research problem**

Since humans knew the concrete material and were able to connect between them and the reinforcing steel in the forms of their design and implementation, the buildings and installations expanded in patterns of shapes and heights in a manner not seen in previous eras, as a result, there were many cracks and more collapses. Sudhakumar



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(2001) pointed out that buildings are exposed to many defects, which affect the validity of the building to be used for the desired purpose.

Narwaria and Tiwari (2016) clarified that there are defects related to the validity of the use, and these defects begin with the emergence of cracks in the sloping walls, followed by the emergence of cracks in the structural elements carrier. There are also defects related to the safety of origin, which are the defects resulting from ignoring the signs of defects in the validity of use, followed by increasing the loads and floors without treating defects until it reaches the state of imbalance or partial collapse of the origin.

### **3.0 Research methodology**

The researcher will use the descriptive approach to achieve the objectives of the study. This approach is based on reviewing several studies, articles and books related to the current subject

### **4.0 Literature review**

#### **4.1 Building cracks**

The cracks are the method by which the building tries to tell the engineer that there is a defect or that it needs reinforcement and restoration. To be successful in repairing the installations it is necessary to know the reasons for the failure of the concrete performance. When these reasons are known, we can choose the most appropriate method and thus reach the desired goals and achieve success.. Therefore, the engineer should distinguish between the views on the forms of cracks and the causes of these cracks. And after identifying the real reason, the solutions can be developed while ensuring that the reasons are not repeated. However, there are number of steps should be followed for a successful restoration of building cracks, as the follows: (Khader, 2011):

#### **First: Evaluation**



The first step is to evaluate the condition of the concrete. This assessment may include a review of the design drawings and structural design note, the examination of concrete by looking and testing the concrete samples in the laboratory using the unbreakable inspection method (Dandona, 2006). After the completion of this assessment, the team will have the complete knowledge of the condition of the concrete and the causes of cracks.

### **Second: Linking the result to the reason**

After the end of the assessment stage, the observations and the results of the tests must be linked to the mechanism of the cracks. Since many cracks can be caused by more than one reason, the engineer must try to find out the actual reason in order to provide the appropriate solutions.

### **Third: Choosing the method of restoration**

After the cause or causes of cracks have been identified, the best method of repair and the materials used are selected.

### **Fourth: The preparation of plans and specifications**

The next step in the repair process is to prepare the structural plans to reinforce the elements that need to be reinforced and the specifications of the materials used for this work. Since some things are not quite clear before the start of the repair work, these plans must be flexible.

### **Fifth: The implementation of the restoration**

The success of the repair process depends on the extent of adherence to the drawings and specifications, which should be higher than the work of constructing new buildings. A structural design engineer who can give full attention to detail must do carrying out the evaluation and designing work.



## 4.2 Modification of installations

Restoration is not required to treat cases of plant failure but is also required as a solution to modify the origin when increasing vertical loads and increasing the number of floors (Kazuhiro et al., 1987). After examining the structural plans and the state of the building, the structural engineer can find that the structural elements bearing the contract (bridges, bridges, pillars and foundations) do not bear the required increase to protect the origin from seismic hazards (increase horizontal loads) (Harrison and O'Ney, 2002).

## 4.3 Methods of restoration

After completing the required studies to determine the structural elements to be repaired, the method of restoration is determined and can be summarized for each element as follows (Khader, 2011):

1. **Foundations** achieved by increasing the loading area on the ground. This can be done by making a block of reinforced or ordinary concrete under the foundation. The base area can be increased by drilling below it. It is a less expensive and less dangerous method (Pablo, 1979). The base area can increase by attaching the separate foundations with wide link bridges to form a continuous foundation, treating iron rust and adding a layer of acid-resistant concrete to protect the iron in the future.
2. **Columns:** the restoration can be done through:
  - A. Dressing the columns with a reinforced concrete layer of not less than 10 cm after roughing the concrete surface.
  - B. Covering the concrete columns with a metal layer (jacket) while ensuring that the metal jacket is connected with the old concrete by grinding the concrete surface and injecting the concrete slabs between them. The connecting can be done using (Fiber Reinforced Plastics).
  - C. Coating the columns using appropriate epoxy.



**3. Bridges and knots:** The thickness of the concrete can be increased from the top or bottom to increase the depth of the concrete section and increase the load capacity by adding iron mesh, using epoxy.

#### **4.4 Repairing, cleaning and maintaining Stone**

The renovation and maintenance of the external structure is an important element in the process of restoration. Stone is a natural material that has been used by humans since prehistoric times and to this day in various uses such as building houses, temples and gates. This section addresses the most important factors affecting the stone's how to maintain, preserve and strengthen it.

##### **1. The most important factors affecting stone:**

Many factors negatively affect stone, including chemical agents and mechanical factors such as heat, humidity, freezing, wind, sea spray, plants and animals. Chemical volatilities are the formation of acids through acid rain. The polluted air makes the rainwater more acidic, and the acid rain attacks the calcareous stone and turns it into calcium sulphate; a fragile black stone (Sofia et al., 2016). Add to this permanent moisture that causes the release of salts dissolved from rock to the surface of the stone when evaporation. It also shows the mechanical effect through the cracks of stone resulting from the change of temperature and humidity and increases the size of the roots of plants and insects, in addition to the environmental pollution resulting from factory waste and car smoke, which negatively affects the stone and help to damage it (Sofia et al., 2016). Therefore, it was necessary to find the appropriate methods, tools and materials necessary for the maintenance and preservation of stone in all its forms. The following picture shows how external factors are shaped on the stone.



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**Figure 1: The effect of the external factors on the stone (Khader, 2011)**

## **2. Restoration materials and tools**

The materials used in the restoration vary according to the problems of the antiquities, such as the use of compresses, distilled water, alcohol and epoxy, as well as the use of chemicals such as sodium fluoride (Aldoasri et al., 2017). The tools used in the laboratory of the stone considered variety, such as brushes of various types and sizes, gears, gaskets of different measurements, cotton, gauze, cloth, iron coolers, turbo air, individual perforation and screwdrivers in different measurements.

## **3. Maintenance and conservation of stone**

The treatment and protection of stone from the various influences that occur includes cleaning, maintenance, reinforcement and completion of archaeological pieces, whether used to build castles and fortresses or making statues.

A. Cleaning: It is necessary to clean the stone technically to strengthen, treat and remove dirt that deforms the stone and lead to the formation of layers that hurt the stone, but excessive cleaning should be avoid in addition to avoid the destruction of the surface or cracks during the cleaning process and should not remove the original material from the stone.



B. Maintenance: It includes the monitoring of the sites and stone statues periodically to know the status and treatment in the event of any damage and must create a special restoration card for each effect includes the following parameters (Khader, 2011):

- The type of stone and its cover.
- The data relating to environmental conditions surrounding it.
- The causes are damaged.
- The purpose of its maintenance.
- The history of maintenance.
- The materials and tools used in maintenance.

C. Tendency and consolidation: The reinforcement and reinforcement of the stone are done by adding the supporting material to prolong the survival of the impact structure and maintain its original state. The methods used in the reinforcement vary according to the material of the stone and its size by either injection or immersion (Aldoasri et al., 2017). It must be ascertained when using the solutions that it does not cause any change in the color or the gloss of the stone.

#### **4.5 Modern technologies for restoration**

The process used for the restoration is different according to the material of the effect and the percentage of damage. The common name is known as the spray carved with hard water, which is the lime water, and the solid water is preferred to pure water or mineral-free water. The latter can analyze the salts in the stone and helps to clean the spray on the stone for a few days and does not harm the water damage, but removes dirt from the stone (Khader, 2011).

Another method is more gentle with stone by using a chemical formula based on ammonium soda, where the restorer mixes this substance with water to become a dough and then supplies it to a piece of fabric placed on the stone surface to absorb the dirt without affecting the stone. Madima (2009) added that the repair teams are now using a more efficient and more precise cleaning mechanism called ultrasound





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that used also by dentists. The restorer uses this technique to treat the cement-covered area. These reservoirs are often rough marble, but the waves are the reservoirs of fossilized salts or Gravel and acoustic can turn it into dust and have proved highly accurate in this field.

It is worth mentioning, that there are other modern techniques used in the restoration, including the use of laser beams. Where the laser used in the restoration of very short flashes, prevents the shortness of these flashes without heating the material under which the laser collides with the stone and the impact of the shock reach to a point that leads to reducing the degree of calcification and turned into dust. This process achieves a high level of accuracy that also contributes to the speed of implementation. It is also an appropriate method for cleaning glass windows and rusting parts of metals as in the pieces of art and statues (Khader, 2011). However, when stones are severely damaged they must be replaced.

## **5.0 Conclusion**

The buildings of archaeological, memorials, monuments and statues are considered evidence of human history and a bridge which moves experiences and social habits between generations and compassion to those buildings that represent the past, people had to be revived past and move the pulse which through the restoration and re-rehabilitation of buildings So that we return to those buildings glamor .

In order to maintain sustainable, the buildings must be re-exploited and used as their non-use is damaged again. Fortunately, there are contemporary techniques used these days in the restoration and contribute greatly to the preservation of heritage and repair the damaged monuments.



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