IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 18, Issue 1 Ser. IV (Jan. – Feb. 2021), PP 35-46
www.iosrjournals.org

Causes of Cracks in Reinforced Concrete Structures, And Some Treatment Methods

Mazin kadhim ferman
Al_Faw General Com. For Exe. Irr. Progects

Abstract
Cracks occur as an unavoidable consequence of unequal concrete tensile electricity, the tensile strength of the metal in the concrete construction elements, and the concrete channels used for irrigation purposes. But, for those reasons, it is very rare to use it to explain a cracking incident on a concrete floor, so we had to evaluate the optimal cracks and the degree of reception. The advent of cracks in concrete and reinforced concrete structures is a sign of defects, but certain types of cracks do not have a bad impact on the ability of the paintings from the perspective of fair requirements.
There are various and varied causes of cracks, and one in all of them may also occur in multiple forms of cracking, and numerous causes may additionally result in one type of crack. The development of concrete cracks varies in line with the factors that contribute to it, and construction or funding may be such factors. It is difficult to prepare a helpful list of the possible reasons for cracking, as it carries many forms and either of them can increase or surpass the risk of the other, and alternatively, propose a crack tree to show the relationship between those forms, which facilitates explaining the possible causes of cracking. The three describe the three historical phases of the beginning's existence: the degrees of layout, manufacturing and carrier, and are divided into lists, the reasons for creating the cracks, and their influence on all else. The tree branches up to the tensile and tensile strength of the concrete roots at the cracking stage. Note that the first branches establish the physical homes of the fissures and make their way through the three stages (breadth, depth, volume, etc) (the restriction of movement is the most critical of those branches). In order to increase the cleaning from a peripheral market set (plant stem), the risk of cracking can be determined, as it causes problems associated with longevity and esthetics, and careful study and repair may be required. The distribution of cracks inside the various engineering components (concrete irrigation channels, columns, trophies, etc.) and what steps are taken to avoid or reduce the occurrence of these cracks. The studies also discuss the cutting-edge methods and the fine drugs used in their rehabilitation.
Keywords: *Irrigation purposes , Concrete ,Defects, Cracks*

I. Introduction

It is understood that reliability, functionality, aesthetics and economy are the basic requirements for engineering facilities. We will not claim that if it does not meet the criteria for longevity, we have an investable engineering facility. And by the resistance of the elements of the facility to the stresses arising from the application of various types of design loads, the state of durability must be achieved without this contributing to the presence of any defects or cracks in the structure.

However, there are different types of cracks during the installation and investment of the engineering facility, some of them are proof of the unsafe and stable structure of the facility, and some of them do not affect the safety of the building, but offer the investors of the facility a feeling of vulnerability and comfort as if these cracks forecast the occurrence of a disaster. Reinforced concrete and concrete structures are prone to time-cracking, and these cracks can occur after several years, months or weeks of implementation of the establishment. The causes of the emergence of cracks are not always easy to ascertain.

Cracks on concrete surfaces can be due to a variety of factors influencing the general appearance of the concrete, which can affect the structural behavior or the collapse of the part, which can only avoid the cracks and contribute to a larger problem. The meaning of cracks is related to the facility form and the design of these cracks. These cracks that are suitable for houses, for example, may not be acceptable for water storage tank installations.

It should be noted that defects in the external appearance of reinforced concrete installations also generate sensitivity and fear among the investors of reinforced concrete installations, especially when such cracks in engineering installations increase and expand. In general, cracks are anticipated in these installations, but by using steel reinforcement in sufficient quantities to meet the design requirements and the necessary specifications, we can limit the crack potential - and significantly. Since one of the phenomena that may cause the building to collapse is the phenomenon of cracking, much research has been devoted to the study of this phenomenon.

The pouring of reinforced concrete buildings on a public site is difficult, even though, for different reasons, they are not under optimal conditions. During the pouring of concrete or immediately after casting, errors can arise. For these factors, poor building materials, insufficient design practices, or mistakes in the impact evaluation may be involved. In some structural details, such as heavy reinforcement or very small parts, bad weather on the various structural components, and the possibility of defects. Bad execution of the concrete mix also causes many defects, from decoloration to extreme nesting, to the emergence of cracks.3 Some of the most common cracks in trophies and columns are also shown in Figure (1).

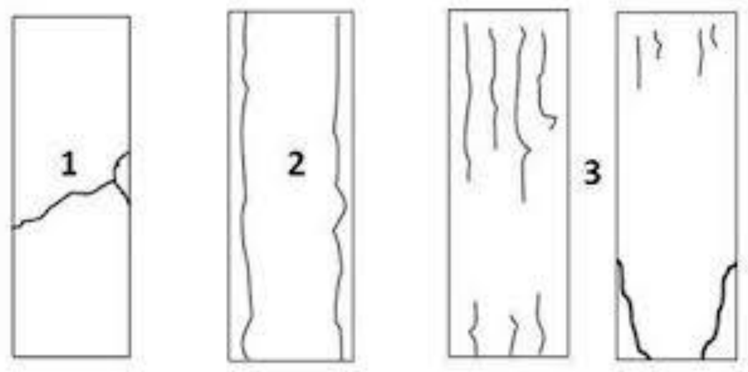

Figure 1. Some of the most common cracks in columns when exposed to tension (1), compression (2); and bending (3)

We can observe three types of cracks, depending on the degree of their activity and movement:

- Passive cracks: can be caused by drying or shrinkage, as their width remains constant.
- Effective cracks: their width does not remain fixed, but they open and close by the load of the structure, or due to the thermal changes of the concrete.
- Incremental cracks: their width increases because the original cause of their occurrence is continuous, an example is continuous foundations or corrosion of reinforcing steel.

Types of cracks

In engineering facilities, the structural elements (columns, trophies... etc.) suffer from deficiencies that are primarily due to inadequate execution, quality and building material requirements, or poor investment in these facilities and lack of maintenance.

Cracks are one of the most significant indicators that allow the engineer to assess the cause of cracks and defects, as for several different reasons concrete cracks occur, and these cracks can have a degree of severity that can impact the life of the house, the following is the list of cracks according to their causes.

Non-Structural Cracks

Plastic shrinkage cracks (shrinkage cracks)

It is due to the rapid evaporation of water from the concrete surface and, as a result of the surfaces being subjected to strong air currents, it is elastic as it hardens. This rapid evaporation depends on many variables, the most important of which are: the temperature and the impact of direct sun make the evaporation rate higher than the water rate.

Plastic shrinkage cracks are typically short and shallow on the surface of concrete, and occur simultaneously in both directions.

Shrinkage is the process of increasing the concrete size without being connected to the load applied, which happens after pouring the concrete mixture and starts at the point of solidification. These changes take the form of a decrease in the concrete dimensions when held in the air. The shrinkage of concrete is one of the common causes of cracks in concrete buildings and structures,5 and the causes of cracks that occur immediately after pouring concrete are vaguely caused by shrinkage. Fast drying of the surface of the concrete, while the center of the concrete portion is still elastic and has discontinuous cracks.

The length of the incisions shall not exceed 280 mm and the cracks shall be diagonal and random in the unreinforced layer, as shown in the figure (2).

Figure 2: Typical elastic shrinkage cracks in an unreinforced concrete slab.

The size and shift of concrete shrinkage over time depends on several variables: 55
1. The shrinkage is growing with more cement than one volume of concrete.
2. Increase the water to cement ratio(W/C) and studies show that more shrinkage is caused by wet concrete than dry concrete. The water-cement ratio must be at its minimum value without any excessive amount of water to decrease the shrinkage occurrence. It can be inferred that all soft materials that require a significant amount of water, such as sand and powder, cause increased incident shrinkage.
3. Soft materials: those who crave water so much, store the excess water between their atoms and induce shrinkage.
4. Concrete stored in sufficient moisture is much less shrinkable than concrete stored in dry weather. If the shrinkage incident is to be minimized, it is important to hold the concrete permanently in a humid atmosphere, especially during the hardening phase, by reducing the humidity by 5-6 times. Therefore, by making burlap bags to cover the cast columns after wetting with water, the heat exchange between the sample - air must be controlled from 85 percent to 35 percent, the shrinkage is roughly increased and the outer medium.
5. The effect of the origin dimensions: the greater the ratio (evaporation surface/volume), the higher the shrinkage, and the slow shrinkage of large structures such as dams, and on the contrary, in thin tiles and walls where the shrinkage is swift.

In the case of reinforcement, the pattern of cracks varies, and the only way to avoid them from happening is to shield the surface from wind and sun during construction, by covering it immediately after the casting has been completed. And, after preparation, we can use remedial steps. By adding cement or polymeric material to a brush. 55

In reinforced concrete structures, shrinkage creates visible cracks if the thickness of the concrete protection layer is less than 0.9 cm or if its thickness is greater than 4.5 cm.

Any special provisions must be made to mitigate the phenomenon of shrinkage, which can be summarized as follows:

Not to waste the amount of water necessary for the concrete mix and to be happy with the smallest amount required. And by spraying with permanent water or placing layers of wet materials such as burlap to minimize the evaporation occurring in the concrete, maintain the concrete immediately after pouring in good humidity.

Tensile stresses in concrete are also a direct result of shrinkage. And the presence of cracks in its surface can be hazardous in certain water installations. By weaponsizing the contraction that we distribute in the directions in which the contraction can occur, we can reduce this effect.

Heat shrink cracks

As a result of the chemical reaction between water and cement, heat is produced during the early hardening procedure. A large amount of heat is always produced and the concrete temperature rises far more than the ambient temperature, especially in bulky elements, and decreases after a few days, not more than / 11 / days. The rate of heat generation falls below the rate of its loss (due to the decrease in the degree of reaction), so that the concrete temperature decreases to the surrounding temperature

Deferential Thermal Strains

The construction method in pre-cast installations helps to be influenced by the temperature differential, the weather difference, and thus, when the two-face interaction happens, cracks appear in the confined gutter.

The structure's normal or thermal outcome is durable. The sudden heat has another consequence, as a sudden rise in temperature often produces a series of cracks if a significant difference in temperature occurs or is allowable between the two sides of the slab. In residential installations, this effect is uncommon, but it can occur in some installations, such as tank walls, and in special situations, when the liquid contained within the tank is hot or very cold.

Cracks caused by the reaction of concrete with sulfates

It results from the use of water containing soluble sulfates or soil mint containing sulfate, and when these substances infiltrate into concrete and interact with aqueous calcium aluminate, they form sulfur calcium aluminate and accompanied by a significant increase in volume that leads to high localized tensile stresses, causing corrosion Concrete and cracked with time.

Reinforcement steel corrosion cracks

Rust develops and grows around the reinforcement of steel, creating cracks along their length, as shown in Figure No (2). In coastal areas, salt saturated moisture carries calcium chloride, so the risk of steel corrosion is high in this case, as shown in the figure (3).

Figure 3. Show steel reinforcement rust and concrete cracks due to rust

Steel corrosion cracks are dangerous for the life of the structure and its durability, as it reduces the steel area in the concrete sector, and this phenomenon is especially dangerous in prestressed concrete.

Structural Cracks

Reinforced concrete is subjected to tensile stresses when the structure is filled, so cracks occur in the trophies (this is normal) under the impact of the turning torque on the side subjected to strain. Experiments have shown that cracking and rust increase rapidly only as mm increases, in general 0.18 mm, so these cracks are appropriate if their thickness is 0.35 mm[7].

But in some cases, these cracks are visible to a dangerous degree, such as:[8]

- Bending or shear moment cracks, which are continuously increasing in width.
- Cracks occur in the parts of the concrete subjected to compression, and this alerts that there is unusual behaviour it occurs at the origin.
- The crumbling of concrete in stress areas (columns, beams, or slabs on the side under pressure), and this is one of the greatest risks to the structure.
- When such types of cracks occur, it may be necessary to reinforce the structure and remove the loads immediately, and then study the basis of the rear origin, and we begin to solve the problem of strengthening the structure and how to treat the cracks.
- An increase in the loads on the structure, or that the reinforcement is insufficient, or that the quality of the concrete is poor ... etc.

As for the causes of structural cracks, they are many, and we will explain below the most important of these reasons:

Cracks due to errors in the structural study

Of the most serious errors:

1. Numerical and arithmetical errors arising from the pace at which calculations are performed, the absence of a reasonable test of numerical results or a mistake in input operations during the programmatic work of the accounts, and the absence of pre-approval audit and examination accounts.
2. Improper structural sentence choice: where structural sentences must be properly chosen based on engineering experience in the preparation of studies.
3. Errors arising from incorrect load assumptions and weight movement at the origin, or failure to take into account real loads such as wind and earthquakes.
4. Cracks resulting from or not correctly putting the small percentage of steel reinforcement within the concrete parts, and this is what we call the art of reinforcement, which allows high stresses to occur in the reinforcement of steel, leading to an increase in the elongation that occurs in it than the allowable values, resulting in the incidence of visible cracks.
5. Neglecting the particulars, positions and delivery of the steel reinforcement and the difference in its diameter.

Cracks due to errors in implementation

Among the most severe of these mistakes,

1. Foundations on soil layers whose properties and requirements do not conform to those which have been accepted in the design or even in the panel.
2. For sweet and saltwater, or for insulation works, badly performed installation works, causing water to seep into the foundation soil.
3. Lack of attention to the information presented in the plans and the performing engineer's dependence on his or her own personal experience.
4. Neglecting and disassembling the cleaning of the wooden cove moulds before the specified hardening time and before the concrete has the requisite resistance to withstand loads of self-weight.
5. A collection of defects related to steel reinforcement: for example, the use of steel reinforcement which does not comply with the technical requirements, in terms of limits; flexibility and diameters; and a decrease in the value of the layer of concrete protection.
6. Lack of interest in the introduction of casting joints in areas not exposed to high forces and strains, and in continuing casting, not roughing their surface for cohesion.
7. A collection of concrete-related errors: such as the isolation of concrete components due to incorrect casting techniques, the occurrence of a phenomenon and the use of mixtures not conforming to technical requirements, incompetence, non-shaking vibrators, honeycombing, nesting and non-cast concrete treatment.

Cracks due to investment errors

Among the most important of these errors:

1. Unplanned modifications to establishments, or their conversion to others to be used for other than the purpose for which they are designed, such as converting some private buildings into public buildings or industrial establishments.
2. Taking leniency in maintaining the various water network (sweet and salty) and allowing it to leak for long periods.

Crack width

It is known experimentally, that we can estimate the width of the crack with the naked eye, but one of the approved methods is to use a display device or a specially designed optical instrument to estimate the width of the crack. Usually, there is no need for great precision in these measurements because it is only necessary to know if the incision is greater than 0.06mm or less than 0.4mm. Since the checks are repeated periodically, it is useful to record whether the widths or lengths of the crack have increased. We explain in Table No. (1) the specifications of the cracks according to their width.[8]

Table 1. specification of cracks according to their width

Slit width	Crack specification
Less than 0.05mm to 0.15mm	Only when dry is it visible, and what is not seen is seen in bright light.
0.15 mm to 0.5mm	Only surface separation can be seen, transparent to the naked eye,
0.5 mm Or more	The two sides of the break in the concrete surface are seen as a discontinuity.

The spread of cracks in the structural elements, and the forms of these cracks
Column Cracks

The distribution of cracks in the columns shown in Figure (4) mainly relates to the quality of the decentralized pressure (small or large eccentricity) and the characteristics of the loads affecting them. Also, we observed the influence of some technological indicators: concrete strength, reinforcement quality, and concrete hardening conditions.

Figure 4. Show cracks in the columns, A. Because of the forces acting; B. Because of the technology of implementation.

Widening horizontal cracks can form in the taut area when the impact of large eccentric loads is affected, which depends on an indication of' increased column loads or inadequate steel reinforcement.' Vertical cracks appear during the application of small eccentricity, which is the result of a shaft overload or a decline in the quality of concrete. The presence (as a consequence of the force effect) of vertical cracks is often followed by shrinkage, which coincides with the direction.

The poor consistency of steel reinforcing longitudinal and transverse welds or the wide spacing of the steel reinforcement cross-section (wristbands) contributes to the loss of cohesion of the steel reinforcing longitudinal bars and the appearance of cracks (Figure 4). The lack of unintended reinforcement in the form of grids (indirect reinforcement) contributes to the appearance of vertical cracks in the region of concentration of pressure stresses in the column heads . And when strengthening or overloading of steel is inadequate, the nails are evident in cracks.

As is understood, columns in which cracks arise as a result of the impact of external forces are protected by encircling metal or reinforced concrete.

The major forms of cracks in columns include the following:

While the column is exposed to normal tensile forces, when the tensile stresses of the concrete are exceeded by the tensile strength of the concrete columns, cracks occur in it in the entire section and are perpendicular to the direction of the force. Or in reinforced concrete columns when the tensile stresses of the steel resistance are exceeded, and these cracks and the bracelets are at equal distances.

Central pressure cracks

Figure 4 shows the cracks due to overloading of reinforced and centrally pressed concrete columns. In columns reinforced with normal reinforcement, and as a result of the appearance of cracks, the concrete protection layer is separated, and this is followed by the twisting of the longitudinal reinforcing steel, especially when the step of the bracelets is large, Figure (4, A). In columns reinforced with helical reinforcement, the cracks shall be vertical and within the concrete protection layer, Fig. (5).

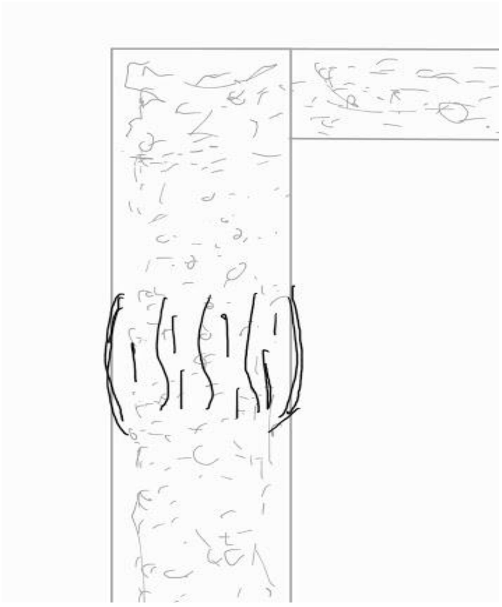

Figure 5. Show cracks in a compact concrete column armed with normal reinforcement , and helical reinforcement

Cracks caused by the subsidence of foundations

The spread of horizontal cracks in the column has a dangerous significance, and it is an indication of subsidence in the foundations under the column, while the horizontal crack in the form of knots is less dangerous and is caused by the plastic drop with the drying of the used concrete, which led to this crack, which is usually when the permissible contact with Column.

1-Cracks due to poor execution

The cause of household cracks is determined according to their location, and if they are in the corners with the railing falling off (the angle of the edge of the column) then it is most likely caused by the rust of the reinforcing rods, and if they are parallel to the occurrence of transverse expansion, then the interaction of alkali with the concrete may be the cause. in concrete with a note in the column, you must search for bracelets in the area of the crack, if they are spaced about what defined specification that is the reason, otherwise, it may be a lack of section or increase the download is the reason.

2-Cracks in covering tiles

The characteristics of slab cracks due to the acting forces refer to the static patterns of the covering slabs, the form and characteristics of the acting loads, the reinforcement system and the ratio of the metaphors of the slab, and the cracks are perpendicular to the main stresses in this case.

Slab overloading, inadequate quantity or incorrect positioning of the main steel reinforcement are generally considered the causes of crack expansion (displacement of the reinforcing mesh towards the neutral axis). Where the width of the exposed cracks is greater than 0.3 mm, the tiles are reinforced by an additional reinforcement process. The cracks on the surfaces of the tiles according to the shape of the slab support and the proportion of the two dimensions are shown in Figure No. (6) and the types of cracks in the tiles and their causes in Table No. (2).

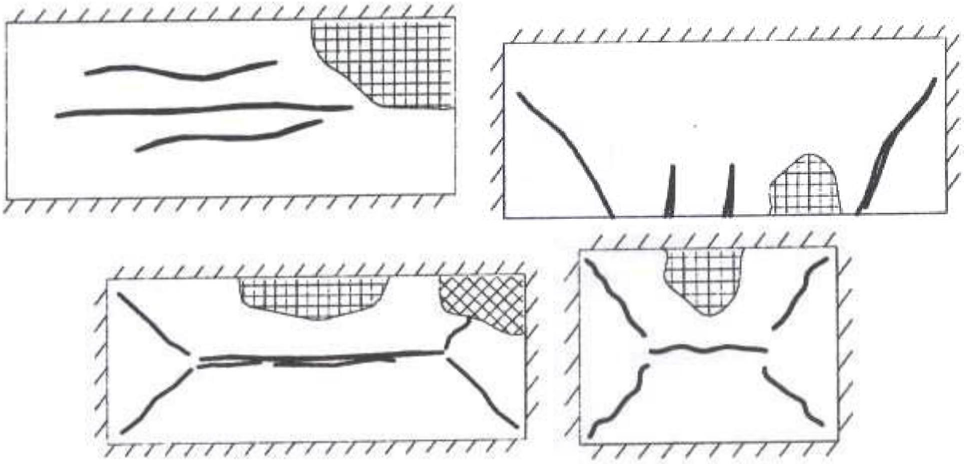

Figure 6. Show cracks on the surfaces of tiles, loaded with regularly distributed loads

Table 2. Show shapes of cracks in tiles and their causes

Form cracks	General description of cleft	Reason
Incisions on the lower face	The emergence of rust spots, and the collapse of the concrete cover, a one-way or two-way incision (in which direction the reinforcing bars will be placed).	Reinforcement steel rust
	With inadequate fixation distances, notches at and parallel to the prizes.	Lack of detail, flaws in execution
	Longitudinal slits in the middle, with an arrow	Overloading or thinning
Cracks on the upper face	Random cracks with crumbling (in cold weather).	Freeze and thaw cracks.
	Random cracks with crumbling (in dry areas).	Concrete shrinkage, improper construction materials
	Capillary cracks on the last surface	Heat stress.

3- Cracks in pre-made tiles

Prefabricated award tiles are foam constructions, which consist of connecting trophies with tiles. Therefore, cracks are formed in them as a result of investment loads, practically no different from the elements of the facilities previously studied, in the prizes. And slabs. This is very clear in the map of cracks in permissible tiles, shown in Figure(6) for hollow tiles, they are characterized by the appearance of cracks - due to the technology of implementation - in the nerves between the voids, and also by the appearance of longitudinal cracks in the upper face of the slab towards the vacuums. (See Fig.7).

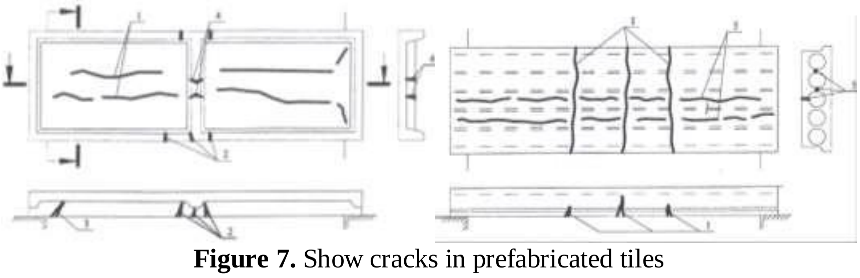

Figure 7. Show cracks in prefabricated tiles

The Procedure for Repairing Concrete

1-Monitor cracks

If they occur in the concrete system, cracks should be noticed and the crack thickness, length and depth should be tested when they do appear. Whether or not the crack widens over time is important to remember. To research this, there are many strategies used, such as using gypsum stains over the cracks and monitoring the incidence of cracks in the gypsum, or using a system that measures the distance between two iron balls fixed on both sides of the crack.

The deformation or curvature of the structural elements in which structural fractures occur must be measured using the known level points as a measurement guide (the final landing of the foundations needs to be known)

and the detection and take-off of various readings will lead us to know the type of cracks at one time in terms of their causes[9].
We demonstrate the methods of detecting the motion of cracks in Figure (9) by labeling the end of the slit, and the subsequent expansion shows the continuation of the crack activity. Or if the slit extends by using a dowel inserted in the slit, the dowel will break. Or on the surface of the slit, we put a tape (Fig. 9).[10].
And contraction using the device (Fig. 9). In general, there can be no static fissure, and the difference between static fissure and the effective one is the amount of movement only.[11]

2-Select a Method of Repair
While choosing the method of restoration, we must determine whether the incision is static or active, and determine the goal of the restoration, whether it is to reduce or prevent leakage.

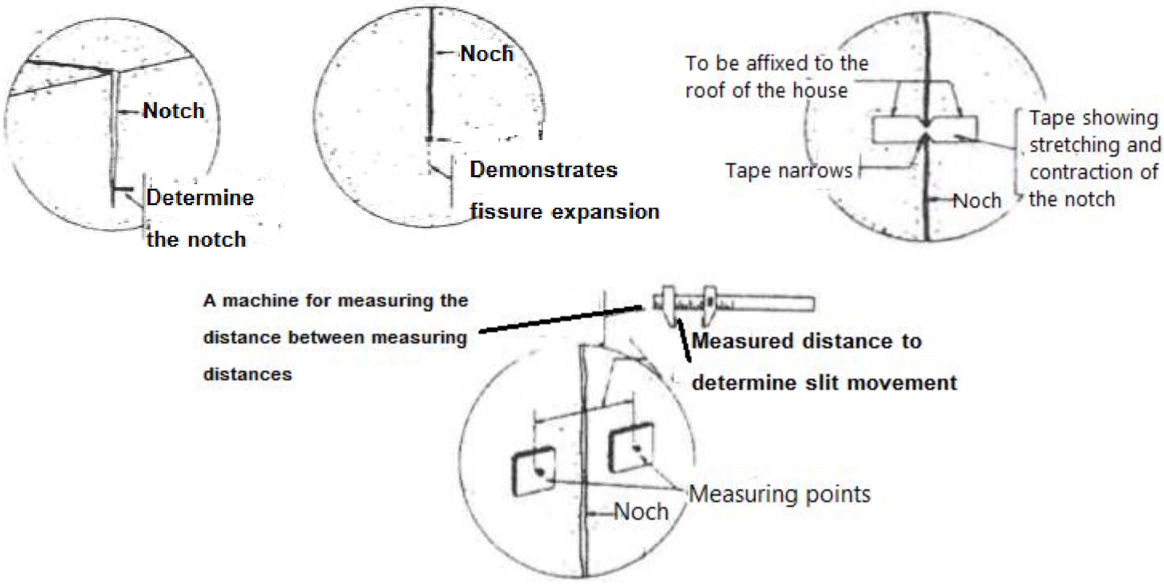

Figure 9. Show methods for detecting crack movement in engineering elements

Method of Repair
We may divide the methods of repair needed into the following:
1. Structural reform refers to those which serve to restore or increase resistance.
2. Non-structural repair techniques include filling in cracks and replacing corroded steel reinforcement.

3-Treatment of non-structural hair cracks (due to non-structural reasons)
In this situation, it is believed that the concrete is of good quality and that the cracks are precise and do not pose a danger to the continuity of the facility. If the cracks are inspected and are the product of normal construction activity, as in the case of connections between pre-cast units, then the builder must measure these cracks and, in particular, the vertical and horizontal joints of the building façade, which must be carefully managed to prevent the damage caused by these cracks (such as water leakage through them). Usually, in the event of actual use, checks are done on broken joints to achieve the true strength of the joints. In order to make the spread of cracks non-hazardous, reinforcement steels should be engineered and picked. The positioning of additional structural steel that is not measured is often needed (such as radial rebar reinforcement steel) and is perpendicular to the direction of the anticipated cracks in the building's corners[12].
In general, the best crack control is provided to us by good design and implementation. By cleaning the surface with a metal brush, the non-structural capillary cracks (such as plastic shrinkage cracks) are treated and the cracks are then added to layers of adhesive cement grout. When the capillary fissures are deep and perpendicular to the direction of the compression forces at the origin, these fissures need to be injected carefully using hot hardening materials. A substance with low viscosity must be selected.[13]

4-Wide cracks
When the width of the crack is large and deep inside the concrete so that it reaches the reinforcement, it must be treated to avoid corrosion of the steel reinforcement. But if this corrosion occurs in the steel, the concrete covering the steel should be removed by cleaning the steel bars and replacing the steel cover. Slide

with good concrete as a cover for reinforcing steel (it is important in this case to use colloidal adhesive resins and to repair with high resistance concrete by air blasting using shot concrete. The cracks resulting from the expansion of concrete are often characterized by their high sulfur content. It may be necessary in this case. Removing and changing the defective concrete, and if the cracks are due to mechanical causes such as increased loads, or lack of reinforcement, or the use of poor concrete, or soil subsidence (we must make sure to control these causes before starting the restoration of the building, especially if these cracks continue to increase.

It may be necessary to remove and change the defective concrete and add a layer of new concrete, for example, we obtain attaching the old concrete to the new concrete using a special paint layer of colloidal elastic material or using epoxy and it may be necessary to put additional steel reinforcing bars in the channels or holes drilled for it In old concrete adhesive iron is grown using an epoxy adhesive monomer and when we decide to inject the cracks, care must be taken to choose the sticky product that we will use according to the order of the cracks and their distribution, and the results of the injection process.

It must be noted that epoxy is used for structural repair of cracks in reinforced concrete, because epoxy is a strong material that has a high resistance to pressure, and its bonding strength with concrete is high. Where we inject 0.01-0.05 mm, as this technique consists of implanting ventilation inlets and outlets close to each other mm, cracks whose width does not exceed the length of the incision, and we inject the epoxy under pressure using a hydraulic pump after testing the injection pressure carefully. In Figure (10) we illustrate the injection treatment of cracks.

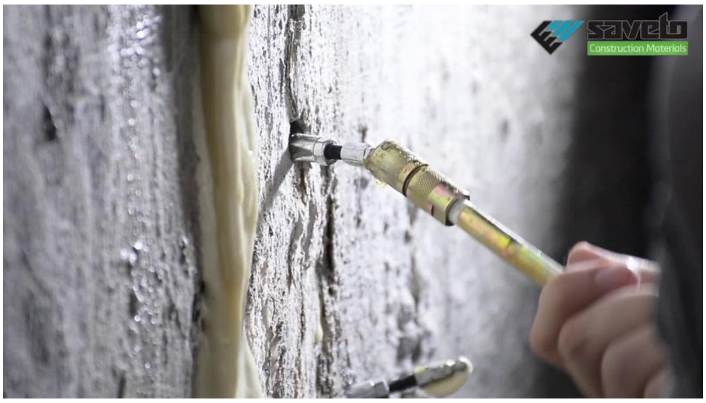

Figure 10. Show treatment of cracks by injection method

If the cracks are active and their width changes due to thermal effects, we must make sure that the effect of tensile stresses and new cracks does not appear after filling the cracks.

5-Treating cracks using flexible materials

Here, we will discuss the solutions and problems of filling concrete cracks, along with follow-up on other repairs required.

To treat cracks, organic polymer and cement are used and we'll refer to them as bonds. Epoxy bonds are the most common organic polymers used in structural restorations. It is a simple resin, hardener, or accelerator for hardening, which must be combined to the specified proportions. Epoxy bonds have a property and have no shrinkage to conform to materials such as concrete and steel. They have elevated tensile strength and pressure as well. Poor resistance to fire and high temperatures is the downside of organic polymers. Epoxy binders belong to the family of free-hardening polymers and they contain polyurethane prepared in the form of two compounds that are combined upon use within their composition. And polyester belongs to the same family. It typically consists of three chemicals, an auxiliary medium dependent on resin and a hardening accelerator.

There is another group of organic bonds consisting of plastic polymers which are quick to harden and do not adhere or acrylic bonds to concrete, and have high shrinkage in dry conditions, so their main use is to seal cracks in conditions of moisture and saturation to resist water leakage and cement used here is cement Ordinary Portland cement, as I do for a low-grade cement, shrinkage and quick-hardening cement can be mixed with organic polymers.[14]

6-Treatment of cracks using the stitching method

With this method, we can treat the tensile strength of the cracked concrete section, using the sewing method as shown Figure (11).

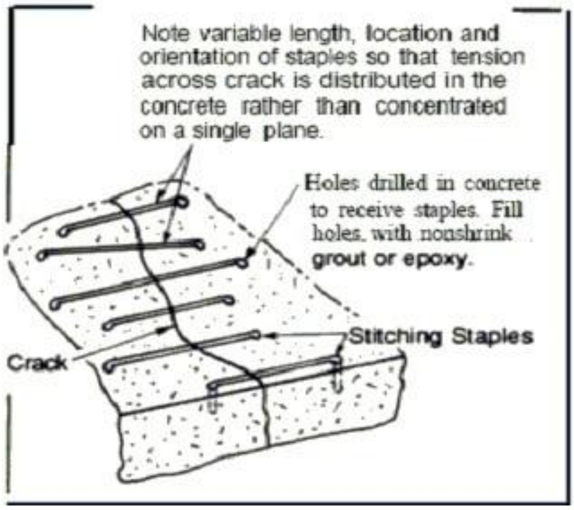

Figure 11. Show seaming Crack Treatment

This method is done by following the following steps:

- We drill holes on both sides of the incision.
- We clean the cracks well.
- It is a metal with short legs; We use U-shaped clamps.
- We fix these hooks in holes using a non-shrinkage mortar or epoxy adhesive, it is desirable to reduce the distance between grapples at the end of the crack.

II. Conclusions And Recommendations

1. The need to take all design steps and precautions, taking into account the existence of the loads to which these components are exposed, to minimize the appearance of cracks in the structural elements.
2. Usage of concrete of decent quality (not less than C-2).
3. Provide an appropriate layer of concrete for the protection of reinforcing steel against corrosive factors of not less than 2 cm for air-impact slabs and 2,5 cm for trophies and columns, so that the width of the reinforcing steel used is not less than the maximum diameter of the reinforcing steel used.
4. Accurate and periodic inspection of engineering facilities, drawing up, if any, a map of cracks in engineering components and identifying their causes and scope.
5. The engineer has accurate scientific expertise that enables him to understand the causes of cracks and the degree to which the protection of the facility is affected.
6. Before conducting laboratory tests on it, to ensure its specifications, not to use any material to treat cracks.

References

[1]. Rabczuk, T., Zi, G., Bordas, S., & Nguyen-Xuan, H. (2008). A geometrically non-linear three-dimensional cohesive crack method for reinforced concrete structures. Engineering Fracture Mechanics, 75(16), 4740-4758.

[2]. Dai, J. G., Akira, Y., Wittmann, F. H., Yokota, H., & Zhang, P. (2010). Water repellent surface impregnation for extension of the service life of reinforced concrete structures in marine environments: the role of cracks. Cement and Concrete Composites, 32(2), 101-109.

[3]. Rabczuk, T., & Belytschko, T. (2006). Application of particle methods to static fracture of reinforced concrete structures. International Journal of Fracture, 137(1-4), 19-49.

[4]. Mackechnie, J. R., & Alexander, M. G. (2001). Repair principles for corrosion-damaged reinforced concrete structures. Research monograph, 5.

[5]. Bažant, Z. P., & Gambarova, P. (1980). Rough cracks in reinforced concrete. Journal of the Structural Division, 106(4), 819-842.

[6]. Safiuddin, M. (2017). Concrete damage in field conditions and protective sealer and coating systems. Coatings, 7(7), 90.

[7]. Narwaria, R. S., & Tiwari, A. (2016). Development of cracks in concrete, preventive measures and treatment methods: A review. International Research Journal of Engineering and Technology (IRJET) e-ISSN, 2395-0056.

[8]. Hollaway, L. C., & Leeming, M. (Eds.). (1999). Strengthening of reinforced concrete structures: Using externally-bonded FRP composites in structural and civil engineering. Elsevier.

[9]. Seifan, M., Samani, A. K., & Berenjian, A. (2016). Bio concrete: next generation of self-healing concrete. Applied microbiology and biotechnology, 100(6), 2591-2602.

[10]. Miyagawa, T. (1991). Durability design and repair of concrete structures: chloride corrosion of reinforcing steel and alkali-aggregate reaction. Magazine of Concrete Research, 43(156), 155-170.

[11]. Zhou, Y., Gencturk, B., Willam, K., & Attar, A. (2015). Carbonation-induced and chloride-induced corrosion in reinforced concrete structures. Journal of Materials in Civil Engineering, 27(9), 04014245.

[12]. Katkhuda, H., & Shatarat, N. (2016). Shear behaviour of reinforced concrete beams using treated recycled concrete aggregate. Construction and Building Materials, 125, 63-71.

[13]. Kakooei, S., Akil, H. M., Jamshidi, M., & Rouhi, J. (2012). The effects of polypropylene fibers on the properties of reinforced concrete structures. Construction and Building Materials, 27(1), 73-77.

[14]. Ramm, W., & Biscoping, M. (1998). Autogenous healing and reinforcement corrosion of water-penetrated separation cracks in reinforced concrete. Nuclear Engineering and Design, 179(2), 191-200.