Subsidence in Low Rise Buildings

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Abstract :

The study aimed to identify the symptoms, types and causes of low-rise buildings subsidence, and the precautions that must be taken to reduce buildings' subsidence. Compression, secondary subsidence, and subsidence in sandy soil. Among the most common causes of building collapse are: earthquakes, inappropriate structural and architectural design, poor compliance with standards and specifications, neglect of building maintenance, and environmental factors, The study put forward some proposals that may contribute to reducing the slump of low-rise buildings.

Key Words : Landing - Buildings - Low Rise.

Introduction :

Man realized the importance of foundations a long time ago, more than 2000 years ago, when the great Roman architect Vitruvius wrote: (The foundations, which are the lowest part of buildings, must be placed on solid soil, if any, and in the absence of it, the ground must be dug under it to reach these foundations. Soil and it must be ensured that the weight of the buildings does not exceed the bearing strength of the soil underneath, otherwise the buildings will collapse). [18]

The fall of buildings is the movement of the structures of the buildings down due to several conditions that may often result from the soil, where this term is used in two cases, the first is when upward movements occur in the ground under the foundations or the occurrence of landslides that lead to the ground sliding downwards. [3]

Study Problem :

The problem of the study is to identify the following :

[1] What are the symptoms of low-rise buildings ?
[2] What are the types of subsidence of low buildings ?
[3] What are the reasons for the collapse of low buildings ?
[4] What are the precautions that must be taken to reduce the collapse of buildings ?

The study attempts to answer the previous questions as follows :

Symptoms of falling buildings :

One of the symptoms of the first subsidence of the foundations is that cracks or cracks appear in the building and its wall, and those cracks resulting from subsidence most often take a diagonal character, and cracks appear suddenly in the plaster works in the building or on the bricks from the outside. [5]

As for the cracks that result from the landing, most of the time they are of great thickness compared to the other cracks that are minute and hairy, which result from the natural movement of the structure and you often find them tend to widen when you go up, and to discover these signs we have to search for weak points inside the building structure such as

doors and windows and so on; It is very likely that we find windows and doors stuck as a result of the movement of the structure of the facility, and cracks resulting from the landing are also spread at the convergence of the extensions to reach the basic structure of the facility; As this extension is pulling in a direction opposite to its original direction, and as a result it is detaching from its primary structure. [7]

The most common sign of differential (uneven) subsidence of foundations is the appearance of cracks in structures tilted at an angle of 45 degrees, usually around openings (doors and windows) if there is a difference in the compressibility of the soil under the structure, or if one part of the structure has bases on rock and another on clay or backfilling, the result is a change in the stress state that is transmitted from the foundations to the structure and the creation of cracks in the walls and structural elements. [9]

These cracks are not the same as the mesh-shaped cracks that do not pose a threat to the stability and stability of the structure and are caused by poor or deteriorating shell; Vertical, horizontal or inclined cracks formed at the edges, corners and corners of structures usually indicate the possibility of differential subsidence. [19]

Types of building landings :

[1] Differential (varying) landing of the foundations :

Soil subsidence is the vertical displacement of the soil surface due to the operating loads and weights of the structures in the building during and after the construction of the building. between the components of the same basis (such as the difference in the value of the decline from one base to another); This could be due to many reasons. [3]

The following figure shows the types of buildings landing as follows : [2]

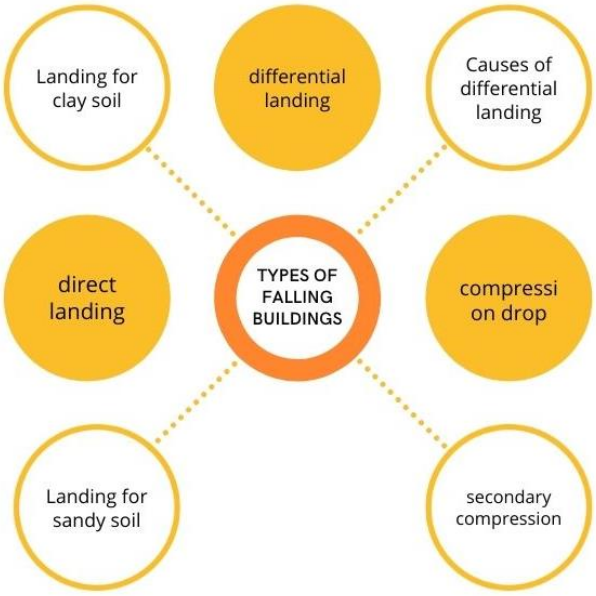

Figure (1) Types of building subsidence

Falling foundations or bases of buildings is a problem that people have faced since they first started building; The subsidence value of the structures primarily depends on the weight of the structure and the deformation characteristics of the bearing soil of the structure. When analyzing this problem, it is necessary to distinguish between the concept of uniform landing and differential landing. [11]

Differential descents of a single structure lead to direct cracks/cracks These cracks resulting from this descent will be at a 45 degree angle and these types of cracks will be mainly observed above or below door or window openings and this visible crack is usually wider at the top than at the bottom. [10]

The following figure shows an example of differential descent : [16]

Figure (2) A low-rise building with a landing

It is clear from the previous figure that the slope and subsidence appears with the naked eye, as a result of the subsidence of the soil on which the building rests. [14]

The most common example of differential descents and their consequences is the Leaning Tower of Pisa, which took two centuries to build due to problems of differential descents and inclination. Building a tall or tall structure is difficult from the start. [12]

The main reason for the differential subsidence and inclination of the tower is the increase in the deformation and pressure of the foundation soil in the area below the southern part of the tower; However differential descents can also cause major problems for other low-rise structures, and it is essential to be aware of the possible causes in order to eliminate them or at least reduce their impact to acceptable limits. [8]

[A] Reasons for differential (varying) subsidence of foundations :

Soils with different component properties in the horizontal direction (different compressibility in the soil under different parts of the foundations of the structure). [6]

- Drying of the soil surface layers under the building.
- Near trees with large roots.
- Pipe leaks, sewage drainage, etc.
- Excavations near the structure.
- Different depth and dimensions of the foundations of the structure.
- by ground vibrations.
- Significant difference between the weights or loads of the structure from one point to another.

[2] Subsidence for clay soil :

There are three types of drop : [4]

[A] The first type is called direct landing : It is the drop that does not result in water leaving the soil and it is called undrained-settlement, and this occurs immediately after loading when constructing the building.

[B] The second type is called compression depression: this is how the drop arises as a result of draining water under pressure, and it is related to time, and it is the largest drop that the foundation is exposed to.

[C] The third type is called creep subsidence or secondary compression: It occurs as a result of the effective stress that follows the exit of excess water from the soil. It is also related to the time following the exit of excess water from the soil. It is also related to time and soil type. The value of this decline is small for the first two types, so it is only taken into account In special cases.

[3] Landing for sandy soil :

It occurs as a result of the high porosity of these types of soil. Usually, direct subsidence occurs immediately after loading, and its value represents 90% of the total subsidence. [1]

Reasons for building collapse :

There are many reasons for the collapse of buildings, which we list below : [14]

[1] Earthquakes :

There are areas that may be exposed to earthquakes, where earthquakes and tremors are supposed to be taken into account when designing concrete works and buildings, where the stress that occurs as a result of earthquakes is calculated according to the American code. [9]

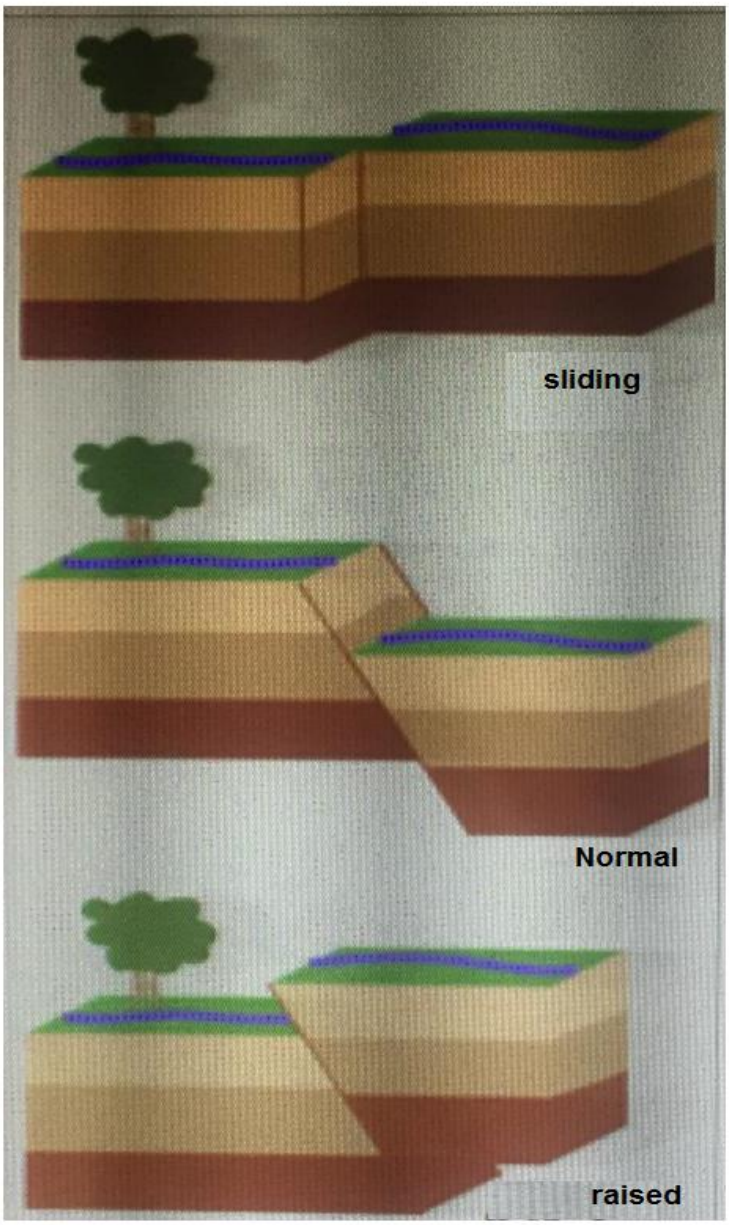

Figure (3) Types of landslide

It is clear from the previous figure that the ground vibrations that afflict the Earth's crust stem from six types of shock waves, two of which are related to the Earth's body as they affect the interior of the Earth, while the remaining four waves are surface waves, and they can be distinguished by the types of movements that affect it. On rock particles, pressure waves send particles oscillating back and forth in the same direction as those waves, and secondary waves transmit vibrations perpendicular to their direction of travel. All over the world, geophysical waves are primary and secondary waves. [13]

[2] Inadequate structural and architectural design :

Occurs in the event that the owner, the person responsible for the implementation, or the designer neglects to complete the design in whole or in part, such as : [15]

- Neglect in the design of the concrete mix and the testing of sand, gravel, water and chemical additives.
- Inaccuracy of the structural design, neglect of standards and codes, and miscalculation of different types of loads.
- Not relying on good reports from reliable sources regarding soil and foundation works.
- Non-compliance with specifications and plans during implementation or implementation in a way that violates them.
- Loss of commitment to the code and familiarity with specifications, materials and executive plans, all of this in addition to the lack of attention to quality control and control during implementation, causes that may lead to problems in the building or its collapse in the future.
- Absence of oversight and quality control for all raw materials and materials used in his project and the extent of their impact on it.
- Using bad materials that do not fit and do not comply with the specifications to save money.
- It is sufficient to inspect the visual materials without making tests for these materials in concrete such as: water, sand, gravel, rebar, cement and additives.
- Non-conformity of rebar with accurate design drawings and calculations.

- Non-compliance with receiving iron and inspecting it before tightening and cleaning it from surface rust, in addition to using rebar of unknown source and old to save more money in the cost of the building.

[3] Poor compliance with standards and specifications :

- Concrete separation occurs during pouring and is caused by the delay of mixing carts and pumps, which may lead to more stirring than required for the components of the concrete mixture, as the period of stirring depends on the speed of the mixer in addition to the use of vibrators in the wrong way and for a large period.
- There are some buildings and facilities that may be exposed to shocks and accidents, especially those close to the main streets and highways, so it is better to make reserves and protect them in proportion to their location and condition.
- Modifications and changes in the use of buildings: There are vast differences and differences in the loads, whether live or dead, between the activities of each type of building. The school is different from the library, the hospital is different from the store, the factory is different from the laboratory, and private housing is different from the hotel... and so on.
- Water, moisture, and neglect of water and thermal insulation may expose the foundations to corrosion and the mixing of various chemicals due to the presence of water at the bottom of the building that leads to reactions with iron and concrete, and the presence of water alone causes rust and corrosion of iron, in addition to what is caused by groundwater, sewage or water resulting from leakage due to damage to the extensions etc.
- The leakage of rain water from uninsulated roofs in a good way, which results in a separation between iron and concrete as a result of corrosion of iron due to rust.
- Neglect in plastering and covering the facades, which exposes the concrete to weather conditions.
- Not paying attention to concrete and taking care of it from the inside by treating insulation damage and draining bathrooms and plumbing in bad ways. Draining washing machines and water from bathrooms have a negative impact because of the chemicals they contain that

affect iron and concrete, in addition to water leakage towards electrical installations in the ceilings of bathrooms and rooms.

- Weak isolation of bathrooms and kitchens with an appropriate waterproofing system, and that it is clear to users how to use and avoid damaging the insulation, whether for bathrooms or surfaces by direct methods such as cracking or indirectly such as using water frequently and immersing walls and doors, which facilitates the penetration of water even with good insulation.
- The large number of unplanned repairs and expansion without studying and using materials that cause damage to iron and concrete.
- Making additional supports in sizes that the foundations or the soil cannot bear.
- Renovation by non-specialist team and unsuitable materials.
- Not taking into account during the restoration any consideration of weight, stress and safety factor.
- Cracking the load-bearing walls.

[3] Negligence in Maintenance :

The concept of maintenance is missing for many reasons that we cannot limit; Western societies give maintenance an importance that may exceed the importance of building construction, and one of the manifestations of neglect of maintenance is the following : [17]

- Maintenance means periodic inspection of every element of the building, and the most important of these elements are the structural elements with modern and advanced equipment to treat any defect in its beginning, as well as attention to everything that may affect the building and its safety.
- Corrosion of iron and concrete Corrosion of steel reinforcement and concrete occurs for one of the following reasons :
    - The proximity of the foundations to the places of drainage, whether for factories or human waste.
    - Corrosion due to neglect of maintenance and immediate treatments for water leakage.
    - High ground water level without taking it into consideration during design and implementation.
    - Large loads or heavy equipment.

- Tremors and earthquakes.
- Change and shift in use.
- Excavation works next to the foundations without taking precautions.
- Leakage of water, whether from rain or other, and the occurrence of a sudden subsidence of the soil for this reason.
- Temperatures due to nearby fires or the atmosphere and the occurrence of separation of walls.
- Problems for neighboring buildings A nearby building may collapse, whether it is completely or partially, it may be eligible to fall. Therefore, the condition of the neighboring buildings must be taken into account, whether during design, implementation, maintenance and repairs.
- Not relying on good reports from reliable sources regarding soil and foundation works.
- Moisture: The movement resulting from moisture is a natural and common phenomenon that affects building components, and is one of the main sources of defects in building components and elements.
- Motion due to moisture can occur as a separate problem or in association with other causes that produce movement, such as heat movement, which generally produces a set of symptoms.

[3] Environmental Factors :

Environmental factors are among the factors that greatly affect the decline of buildings, such as : [15]

[1] Volumetric changes that occur in the soil under the building as a result of soil compaction is mainly as a result of the convergence of soil particles, so we find that soils with large particles, such as sandy soil, whose diameter ranges from 2 mm for coarse sand up to 0.2 mm for fine sand and up to 0.06 mm for the most Fineness: Compression occurs faster than clay soils whose part diameter is less than 0.002 mm. Therefore, we see that the landing of buildings built on clay soil takes longer time to descend than those established on sandy soil.

[2] The effect of static loads such as those caused by the building itself.

[3] The change in the moisture content in the soil, for example, we see a difference in the moisture content as a result of the rise and fall of the groundwater level, the difference in the level of infiltration water, or the change in the moisture percentage as a result of water absorption in the soil by the roots of plants and crops.
[4] The effect of dynamic loads, such as those resulting from the presence of special fulcrum machines, if their location is creeping close to the building fulcrum points.
[5] Existence of excavation works next to the building, which causes the loss of special supports due to the encroachment or flight of the soil.
[6] The effect of vibrations, especially in soils with loose grains (loos grane-soil), such as those resulting from heavy or fast traffic.
[7] Decomposition of the foundation as a result of the presence of organic materials or dissolved salts in the soil in high proportions.
[8] Soil decomposition under the building.

So there are many precautions to be taken to reduce building collapse :

Precautions to be taken to reduce building collapse :

Failure to take technical precautions and follow engineering standards when establishing on parasitic soil without replacing the soil with good soil compaction, and not being careful about the presence of chemicals in the soil may lead to erosion and interactions of concrete and rebar, and this occurs whenever the building is close to factories and waste dumps, and neglecting tests and tests Soil stress is a major and important factor that many people neglect for many reasons, the most important of which is the desire to save and obtain licenses in a fictitious way and assign the matter to non-specialists; There is also the problem of foundation on ruins and areas of backfilling or archaeological places, as this means that there are layers of backfill that must be removed to reach the appropriate land for foundation and according to the technical reports received from construction specialists in areas prone to collapse without taking this into account during the design. [11]

There are some recommendations that should be taken into account to reduce the slump of buildings and to avoid irregular landing; It consists of the following : [9]

[1] The accurate calculation of the actual loads of the building taking into account the dead and live loads and the forces resulting from wind pressure, vibrations and eccentric loads.

[2] Good testing and accurate design of the type of foundation in relation to the type of soil present, provided that the stresses generated by the building are within the safety limits for the ability of the soil to bear the stresses.

[3] Keeping the foundation level as far as possible from areas of vibration, such as areas adjacent to railways or exposed to heavy transport traffic.

[4] Avoiding the foundation on soil whose water content changes frequently as a result of the high and low level of infiltration water, such as the soil near canals and waterways.

[5] Avoiding excavation works, especially the deep ones adjacent to the foundations, to prevent the encroachment of the soil.

[6] Avoid lowering the level of infiltration water, especially if the foundations are shallow.

[7] Calculating the amount of subsidence over the life of the building and taking it into account.

[8] Rapid treatment of any slump that arises in the building, whether by lightening the loads, treating the foundations, or injecting the soil.

[9] Avoid establishing a single building on more than one type of soil, and in case of necessity, the building is divided as a unit into parts with breaks between them.

[10] Taking into account the cohesion of the building as a single unit, by increasing the structural sectors for the foundations and arming the ridges with special armament.

Methods of preventing and treating the consequences of differential subsidence of the foundation : [7]

- Study the surrounding environment.
- The soil on which the building is erected should not be of a loose nature.
- Connecting the rules or using a cloth.
- Appropriate soil treatment, ie strengthening the soil.
- Laying all foundations/bases at the same level.
- Avoid foundation in soils that are subject to cycles of drought and wetness.
- Reduce the space between columns.
- Distribution of loads in a proportional and convergent manner.
- Use fallen beams whenever possible.
- Attention to the implementation of the Maidah or Saml.
- Review the design well.
- Selection of a reputable contractor.
- Providing periodic engineering inspection and supervision.
- Compaction of foundation soil before foundation implementation.
- Plant trees away from the building.
- Implementation of the drainage and plumbing system tightly.
- Stay away from orchards and primitive septic tanks.
- Commitment to the terms and conditions of construction in the region, especially the depth of foundation.
- In the case of excavation more than the level, do not try to fill in a random way again. Deal with the excavation difference or backfill the excavations using good soil (replacement soil) and in layers not exceeding 25 cm with tamping and leveling. Replacement soil layers should be tested.

Discuss the results :

It is clear from the above that the reasons for the decline of low buildings do not have to be caused by a height in buildings or land area, but it has many reasons that were previously mentioned, so there are many precautions that must be taken to reduce the decline of buildings in low buildings, including: Obligation to inspect the surrounding area The building and the detection of the soil and buildings adjacent to the building

and any cracks or subsidence in the surrounding buildings, in addition to resorting to specialized laboratories in geology to identify the type of soil, in order to determine the mechanism by which we will deal with this soil and the appropriate constructions, and the treatment of foundations can be achieved through The application of many techniques, the most widely used, namely: curing foundations by concrete reinforcement, curing foundations by soil injection, treating foundations with micro piling, curing foundations using injection of expandable geopolymers, given the possible causes of differential subsidence of foundations and its impact on the overall stability and balance of structures buildings; It is necessary to take them into account when designing foundations for various structures in order to reduce the effect of differential landing to an acceptable and safe level.

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