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STUDY OF THE EFFECT OF ACID RAIN PREPARED IN THE LABORATORY ON BUILDING MATERIALS IN SALAH AL-DIN/ IRAQ

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Abstract
This study was conducted in the laboratories of the Department of Biology, College of Education for Pure Sciences, in which choosing all kinds of building materials (solid block, hollow block, ordinary bricks, bricks dyed) and collected from block and brick factories. The samples were exposed to acid rain, which was prepared in the laboratory from distilled water and sulfuric acid and dropping it on the samples to know the effect of acid rain on building materials. It was observed after the first experiment, which was inside the laboratory and under controlled weather conditions for a period of 15 days. On a day and at a daily rate of exposure to acid rain, there is erosion and a decrease in the weight of the mentioned samples compared to the weight of the control samples, the highest percentage of corrosion and a decrease in weight were in the solid block sample by 0.145Kg, and the lowest corrosion percentage and a decrease in weight in the dyed brick sample by 0.005Kg. The second experiment was conducted outside the laboratory in which the samples were exposed to different atmospheric conditions and for acid rain for 15 days, with a daily drop rate of 3.7 ml for each sample, and the weight of samples had decreased after exposure to acid rain compared to the weight of samples after the first exposure and the weight of control samples. The highest percentage of erosion and weight loss in the solid block sample was 0.270 Kg, and the lowest percentage of corrosion and a decrease in weight in the dyed brick sample was zero. That mean there were clear effect of acid rain on buildings materials, so it must not left under effect of rains.

Keywords: Acid rain, building materials, corrosion, experiment.

1-Introduction

Pollution is one of the current topics, as pollution is a constant source of concern for the different segments of society, due to its multiple forms and the expansion of its forms that negatively affect the environment and human health (Al-Dabbagh, 2006). Air pollution, which is one of the forms of environmental pollution, has become one of the biggest problems facing contemporary societies, especially industrial ones and its dilemmas exacerbate with the progression of time with an increase in the concentration of various pollutants presented and the generation of types of pollutants that harm the environment. Therefore, air pollution is the real danger that threatens human life, wealth and property due to its limitations on the one hand and the absence of an alternative to it on the other hand (Al-Zubaidi, 2010).

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One of the most important air pollutants is acid rain. The emergence of this acid rain seems to have accompanied the beginning of the industrial revolution in the mid-nineteenth century. This rain was mentioned in a report written by a British chemist, in 1972, called (Robert Angus Smith) and this report is located in About 600 pages, in which this British chemist linked, for the first time, between smoke and ash rising in the air from factory chimneys in Manchester, England, and that acidity observed in rainwater falling on the surrounding areas of this city, acid rain has a pH of approximately 5.2 or less. It occurs as a result of the emission of sulfur dioxide and nitrogen oxides, a mixture of nitric oxide and nitrogen dioxide resulting from some human activities, often due to the combustion of fossil fuels, and under the influence of ultraviolet rays emanating from the sun, and as a result of the union of sulfur trioxide with water vapor suspended in the layers of the atmosphere, sulfuric acid is produced (Islam, 1990).

Acid rain can be in the form of dust, gases, snow, fog or hail, and acid rain that contains water is called wet precipitation, while acid rain that consists of dust or gases is called dry precipitation, and winds play an important role in transporting what it remains stuck in the air from a fine mist, and everything that is transported with gases such as ammonia is combined, and this results in a new compound, ammonia sulfate. They fall in the form of acid rain on the ground (Ministry of Municipality and Environment, 2019).

1_2_Research Objectives

1_ Test the effect of acid rain on types of building materials.

2_ Determine the types of building materials affected by acid rain more than others according to their components.

3_ Knowing the amount of corrosion of building materials on a monthly basis, according to the pH of acid rain.

4_ The impact of the rest of the weather factors such as heat, humidity, wind and others on the amount of corrosion in building materials.

5_ Paying attention to improving the types of building materials to reduce the amount of corrosion that occurs in them as a result of acid rain.

2_Literature Review

2_1_ Environment

The environment is everything that makes up our surroundings and affects our ability to live on earth. The air we breathe, the water that covers most of the earth's surface, and the plants and animals around us. The environment consists of a mixture of biotic and abiotic factors that surround us and other living things, and biotic factors include water. Air, soil, light, temperature, etc. affect humans less, biotic factors are other factors that affect the environment much more compared to abiotic factors, biotic factors consist of all forms of life such as animals, plants and microorganisms, and humans are an integrated part of the environment and have a relationship intimacy with each other. (Khalil, Farid, 2013). The environment is the group of things that

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surround us from living and non-living organisms, and the environment can also be classified into a natural environment and a built environment. (Al-Zubaidi, 2010).

2_2_ Environmental pollution

Environmental pollution is the presence of polluting substances with different concentrations that are harmful to living organisms, soil, air and water, from natural and unnatural sources, and cause great harm to the environment, including the dumping of waste in the form of black smoke emitted from factories. Pollution can be visible and invisible, and without comfort. Or taste, and some types of pollution may not actually cause soil, air or water pollution, but they disturb human life and other living organisms. (Dawagreh,2017).

2_3_ Natural pollution factors

2_3_1_Natural factors

These sources include both natural phenomena such as volcanoes and some types of greenhouse gases emitted from nature

2_3_2_ Industrial factors

All of them are caused by man and caused by development and renaissance, examples of which are factory smoke, waste water, gases resulting from burning waste, pesticides and fertilizers, solid pollutants, packaging materials, cigarette smoke, car and factory smoke. (Al-Hassan, 2014).

2_4_ Types of natural pollution

The environment is polluted by several types, including the pollution that affects the soil, air and water, all of which are types of causes that lead to this pollution. We will explain about air pollution to show the beginnings of acid rain (Shehadeh, 2008).

air pollution

Air pollution means air mixing with certain substances, such as exhaust fuel and smoke. Air pollution can harm the health of plants and animals, and destroy buildings and other constructions. The World Health Organization estimates that nearly one-fifth of the world's population is exposed to hazardous levels of air pollutants. The atmosphere, in its normal form, consists of nitrogen, oxygen, small amounts of carbon dioxide, other gases and aerosols (fine particles of liquid or solid substances). A number of natural processes maintain the balance between the components of the atmosphere. When plants consume carbon dioxide and release oxygen, animals in turn consume oxygen and produce carbon dioxide through the respiration cycle. Or scattered by rain or wind (Shehata, 2000).

Air pollution occurs when factories and vehicles release large amounts of gases and particulates into the air, in a way that natural processes fail to maintain the balance of the atmosphere. (Al-Ta'i, 2012).

Every year hundreds of millions of tons of gases and particulates are released into the atmosphere, and most of this pollution occurs as a result of the combustion of fuel used to operate vehicles and heat buildings, and from industrial and commercial operations. Dry clothes to remove dirt from clothes. Burning waste may lead to the

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release of smoke and heavy metals such as lead and mercury into the atmosphere, and most heavy metals are very toxic (Makhlef, 2007).

One of the most common air pollutants is smog, which is a misty mixture of brown gases and particulates, which is formed when certain gases, released as a result of the combustion of fuels and other petroleum products, interact with sunlight in the atmosphere, as this interaction results in harmful chemicals that form smog (Kato, 2010), air pollution leads to the formation of acid rain and the term acid rain is applied to rain and other forms of precipitation, which are polluted mainly by sulfuric and nitric acids, and these two acids are formed when sulfur dioxide and nitrogen oxides interact with water vapor in the air, and these gases are produced Mainly on the combustion of coal, gas and oil in vehicles, factories and power plants (Kato, 2010).

The acids present in acid rain move through air and water, and cause damage to the environment over large areas. Acid rain has killed entire fish populations in a number of lakes, and also leads to damage to buildings, bridges, and monuments. Scientists believe that high concentrations of acid rain can To cause damage to forests and soil. (Mohammed, 2008)

2_5_ Acid rain

The term acid rain refers to rain and other forms of precipitation, which are polluted mainly by sulfuric, nitric and carbonic acids (Al-Hamdani, 2012). Where rain water descends from the sky free of impurities, and on its journey to reach the surface of the earth, pollutants in the air are attached to it, including carbon oxides, sulfur oxides and dust particles. Acid rain also consists of the emission of nitrogen oxides from various transport media, where these oxides combine, as in nitrogen dioxide gas with water vapor, to form nitric acid, which causes acidic rain (Kulp, 2001).

All these pollutants combined with each other will dissolve in the rain water to form another element, not only to pollute the soil as well, as this acid rain reaches the soil, so the plant absorbs toxins from the polluted rain water and stores it for humans and animals to eat after that, leading to their poisoning (Azi, 1995).

Also, this polluted rainwater exposes marine organisms to pollution as a result of these rains falling on water bodies, and a new cycle of human consumption of toxins through contaminated fish begins, meaning that the arrival of pollutants to humans takes place in several ways as if it is a vicious cycle that we cannot find a beginning or an end (Jawad, 1998), Acid rain is a recent environmental phenomenon that has been called cross-border pollution (Watmough, 1999).

The beginning of its discovery was in 1970 in the Scandinavian countries, when it was discovered that a number of Norwegian lakes and ponds had become acidic and this caused the disappearance of a number of its aquatic life (Burden et al, 2002). The source of this acid rain falling on Norway came from its possession of a number of industries that throw their waste into the air and cause the airspace to be polluted with these acids.

The problem of acid rain has exacerbated after air polluting factories increased the height of their chimneys in order to disperse pollutants with the air stream, but this

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on-site treatment led to the transmission of pollutants by wind to long distances from their emission sources, and this may take several days, as sulfur and nitrogen oxides turn into Sulfuric and Nitric Acids (Age, 2000).

Acid rain is measured using the pH scale, which is 7.0, the more alkaline the substance is, the higher the pH of the substance (greater than 7), the more acidic the substance is, the lower the pH of the substance is (less than 7). Ordinary rain has a pH of about 5.6, it dissolves again Carbon dioxide has a weak carbonic acid component, acid rain usually has a pH between 4.2 and 4.4 (Arti, 2010).

Acid rain affects plants, weakening them and increasing their susceptibility to damage from other stresses, such as drought, extreme cold, and pests, in acid-sensitive areas. Acid rain also depletes the soil of important nutrients for plants such as calcium and magnesium. Acid rain contributes to the erosion of surfaces exposed to polluted air. It is responsible for the deterioration of limestone, marble, buildings and monuments (Abdul Rahman Kamel, 2004).

Negative Effects of Acid Rain

Acid rain causes health, environmental, economic and social damages as follows:

1_ It caused damage to many buildings and changed their colors, especially the historical and archaeological ones. (Al-Hamdani 2012)

2_ The erosion of memorial statues, sculptures and ancient monuments, such as the erosion of the Taj Mahal statue in India and the Cleopatra's obelisk located in a London square (Staintsiki et al, 2000).

3_ Cotton and nylon fibers rupture, rubber and leather cracks, and the pigments used to paint cars, buildings and facilities, so that acid rain increases the speed of their decomposition (Alloway and Ayers, 1997; El-Gendy, 1998).

4_ Increased acid rain affects the waters of rivers and lakes, as it changes the natural conditions experienced by fish and other organisms, as well as affecting aquatic plants (Ashour and his group, 1999). An example of this is what happened in the clear Moose Lake, west of the Adirondack Mountains, where trout and frogs disappeared, even the snipe ducks had migrated, and the sniper bird that dived into the water disappeared as a result of acid rain (Echo and his group, 1998). For example, the number of lakes affected by acidity in Sweden since the seventies of the last century and so far 2500 lakes, of which 1750 lakes lost their fish permanently as a result of the settlement of these lakes on a layer of weak granite rocks resistant to acidity (Colls, 2002).

5_ It helps in the deposition of dust, which affects the growth of plants and infects them with diseases, as well as the absorption of toxins in acid rain by plants when this rain falls on the soil (Abdul Razzaq, 2000).

6_ Acid rain washes away with it various metallic elements, some of them in the form of compounds of mercury, lead, copper and aluminum, killing the living things in the lakes and increasing the pollution of the soil with these elements (Jawad, 1998).

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7_ Acid rain affects economic plants with seasonal crops, such as coniferous forests, as it strips trees of their leaves, and disrupts the ammonia balance in the soil, and thus makes absorption disturbed in the roots (Islam, 1990).

This makes trees lose their quality, and thus leads to an economic loss in the destruction and deterioration of forests, especially if we know that forests release 1300 tons of oxygen per square kilometer, and absorb about 1640 tons of carbon dioxide during one growing season (Awad, 1996).

8_ High soil acidity leads to a decrease in the activity of some bacteria, such as: nitrogen-fixing and a decrease in the rate of dissolution of organic matter (Colls, 2002), which leads to a thickening of the layer of plant residues to the extent that it impedes the permeation of water into the soil, and to the inability of seeds from germination, and eventually leads to a decrease in productivity (Tabeel, 1989).

9_ Smog forms in large cities when it is suspended in the air (Abdul Hamid and his group, 1996).

10_ Acid rain leads to an increase in weathering rates in building materials and buildings, especially in limestone and cement (Nashi, 2011).

11_ The corrosion of metals used in construction, bridges and industrial facilities, and it mainly affects nickel, zinc and copper (Ahmed, 1995; Al-Rawi and Al-Tayyar, 1997).

2_5_3_ The effect of acid rain on buildings and stones

The harmful effects of acid rain extend to buildings, facilities, cement and iron bridges, where they are eroded and damaged, and limestone and marble turn into a gypsum-like and brittle substance, and this is what happened to one of the bridges extending over the Ohio River in the United States of America in 1967, And led to its collapse due to the erosion of its walls, which led to the death of 46 people, and many of the artifacts, which withstood thousands of years in the face of nature factors, were destroyed by acid rain during the past fifty years. Italy, the Karnak Temple and the Sphinx in Egypt, the Taj Mahal in India, and hundreds of precious artifacts around the world. Metal and stone, as well as colored glass and plastic. Some types of building materials are softer than others, and this is the softer ones that are most affected by acid rain. Sandstone and limestone are examples of stone which are rather soft and easily damaged. Granite is an example of a harder stone that can resist the effects of acid rain.

In many places in the world, old and famous buildings and monuments are affected by acid rain. For example, the Statue of Liberty in New York, USA, had to be restored due to acid rain damage. Buildings are naturally eroded by rain, wind, frost and sun, but when acid gases are present, it accelerates corrosion. (Torry, 2009)

Old statues, monuments and tombstones are vulnerable to acid rain because they are made of limestone. Over decades of exposure to acid rain, details of a statue can be lost, slowly turning them into rare spots. Acid rain also attacked the words engraved on some tombstones, making them unworkable. to read, Although metal sculptures resist physical deterioration from acid rain better than stone, they can develop and change color (Al Mansouri, 2016).

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You might expect that protected areas of stone buildings and monuments will not be affected by acid rain, however, protected areas on limestone and marble buildings and monuments show blackened crusts that are spalled (peeled) off in some places, revealing the collapse of the stone underneath and this black crust is formed primarily It is gypsum, a mineral that forms from the reaction between cassette, water, and sulfuric acid. Gypsum is soluble in water and it can form anywhere on limestone surfaces that are exposed to sulfur dioxide gas (subodh, 2017).

Materials and Methods

3_1_ Description of study areas and samples

The experiment was carried out in the laboratories of the department of biology, College of Education for Pure Sciences, Tikrit University, for the period from 1/2/2021 to 1/3/2021. The measurements were made in the soil laboratories of the College of Engineering, Tikrit University.

Four types of samples were taken, which consisted of building materials (Solid block, hollow block, bricks, and painted brick (tile)) in addition to four control samples consisting of the same materials mentioned above.

3_2_ Methods of preparing samples and rain

The samples were exposed to acid rain, which was prepared in the laboratory on a daily basis, due to the constant change of pH values and their instability.

The percentages of pH ranging between (3_5.5) were selected, according to the measurements of acid rain falling on Tikrit (Al-Hamdani, 2012). Also, to confirm the result, rain water samples were collected from different areas of the city of Tikrit (University, Al-Zohour, Qadisiyah, Doctors). During the period of work 5 times, the pH values ranged between (2.5_5.5) according to the following table:

Table (3_1) Rainfall rates for the mentioned areas

Region	1st collection	2nd collection	3rd collection	4th collection	5th collection
University	5.4	5.1	5	4	5
Al-Zuhour	4	3.4	2.5	3.4	4.2
Qadisiyah	4.8	4.1	3.2	4.4	4.8
Doctors	4.6	4	2.9	4.1	4.5

Samples were prepared by adding drops of H_2SO_4 acid to distilled water until the required pH was reached, according to (www.omicsonline.org). The amount of rain falling in the month of February of the year 2020 on the city of Tikrit was 111 mm, according to the data that was provided to us from the Meteorological Department. In the district of Tikrit, Salah al-Din governorate, and by converting longitudinal measurements to volumetric measurements (Ahmed and Ibrahim, 2002), 111 mm equals exactly 111 liters. To calculate the amount of daily precipitation, which equals 3.7, 3.7 of acid rain per day was prepared and distributed to the four samples.

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3_3_Methods of work

The samples were exposed to acid rain prepared in advance inside the laboratory with control over the weather conditions from winds and storms, and measurements were taken after 15 days, The samples were also exposed to acid rain outside the laboratory with exposure to different weather conditions such as sun heat and wind, and measurements were taken after 15 days.

3_4_Components of the study samples

The materials constituting the samples used in the current study, which consisted mostly of sand, gravel or gravel, cement and water, according to the percentages mentioned in front of each sample in the table (3-2).

Table (3_2) Components of study samples

Name of the sample	Cement	Water	Sand	Pebbles
Solid blocks	1.5 kg	1.6 liters	13.5 kg	5 kg
Hollow blocks	1.25 kg	0.8 liters	9 kg	7.3 kg
Bricks	consists of red clay and sand at a rate of 25-30%. Added percentages of water as needed. It is pressed into solid molds and entered in ovens at a temperature of 1000 degrees Celsius. It is possible to add some materials such as straw, cement or plaster according to the manufacture of the factory			
Tile	consists of very soft clay that is crushed and the addition of percentages of water and anthracite coal because it helps in combustion and the adhesion of dust particles to each other strongly. Like red and green made of a mixture of brass, lead and sand.			

These values from factories the table (3-2).

ach

sample.25

Results and Discussion

The results in Table (4_1) showed that the weight of the samples mentioned before the first exposure to acid rain was as follows (solid block 26.050 Kg, hollow block 21.385 Kg, brick 2.595 Kg, brick 2.095 Kg), but after the first exposure to acid rain prepared in the laboratory from distilled water and acid H_2SO_4 to reach the specific pH, whose measurements are mentioned in Salah Al-Din Governorate, Tikrit District, according to (Al-Hamdani 2012), that its acidity reached a limit of (3_5.5). According to what was stated in the results and lists of the Salah al-Din Department of Tikrit District for the year 2020 (Salah al-Din District Department 2020), and by dividing by one month, the amount of daily exposure becomes 3.7 ml for each sample, The percentages of sample weights decreased after the first exposure to acid rain inside the laboratory and

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under controlled environmental conditions for a period of 15 days as follows (25.905 Kg solid block, 21.245 Kg hollow block, 2.480 Kg brick, 2.900 Kg Tile) compared to the control samples which were (26 Kg solid block. 076, hollow block 21.399 Kg, brick 2.605 Kg, tile 2.080 Kg). These results agreed with what was stated in (Mohammed, 2011, Mohamed, 1997, Bakr, 1998 and Thomas, 2018). The weights of the samples decreased after the first exposure in proportion to the measurements. Before exposure and in proportion to the weights of the control samples, and the highest decrease in weight was in the solid block sample due to the effect of the sand material constituting the sample more than the rest of the solid block components and because it constitutes (48%) of the total block weight, As for the second sample, the hollow block, the weight loss was less than the first sample because the percentage of sand in the hollow block sample was less than the first sample and the percentage of cement was more. The weight decrease in the third sample, the bricks, was less, because it consisted of dirt and a small percentage of sand. It was subjected to strong pressing and a temperature of C1000°C, which helped reduce corrosion when exposed to acid rain. The least weight loss was observed for the brick sample due to the presence of an insulating layer of dyes on its surface that prevents the acid rain from permeating into the sample, which led to protection from corrosion.

Table (4_1) Samples weight before and after first exposure to acid rain

Sample name	Sample weight before exposure	Sample weight after first exposure	Amount of exposure	Amount of erosion	Weight of the control sample
Solid block	26.050Kg	25.905Kg	55.5L	0.145 Kg	26.076Kg
Hollow block	21.385KG	21.245KG	55.5L	0.140Kg	21.399Kg
Bricks	2.595KG	2.480KG	55.5L	0.115Kg	2.605Kg
Tile	2.095KG	2.090KG	55.5L	0.005Kg	2.080Kg

The results in the table (4_2) below showed that the weight of the samples before the second exposure was (solid block 25.905 kg, hollow block 21.24 kg 5, normal brick 2.480 kg, brick 2.090 kg), while after the second exposure to acid rain prepared in the laboratory on a daily basis from distilled water And sulfuric acid to reach the pH mentioned its measurements in Salah Al-Din Governorate, Tikrit District, according to (Al-Hamdani, 2012) that its acidity reached a limit of (3_5.5). The one according to the results and lists of the Salah al-Din district, Tikrit district, for the year 2020 (Saladin District 2020) by dividing by one month, the daily exposure amount becomes 3.7 ml for each sample. The weights of the samples decreased after the second exposure to acid rain outside the laboratory and under the influence of sunlight and wind for a period of 15 days as follows (solid block 25,635 kg, hollow block 20,985 kg, normal brick 2.475 kg, brick dyed 2.090Kg). These measurements agreed with what was stated in

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(Ahmed, 2008, Alaa Aldin 2004, Muhammad, 1997 and Bakr, 1998). The weights of the samples decreased after the second exposure relative to the measurements after the first exposure and relative to the weights of the control samples, and the highest decrease in weight was in the eyes of the block Solid because sand is affected by one of the components of the sample more than the rest of the components of the solid block because it constitutes (48%) of the total sample weight. The weight loss in the second sample, the hollow block, was less than the first sample, because the sand material consisting of it was less than the proportions of the first sample. The weight loss in the third sample, the ordinary brick, was less than the previous two samples, because the sample had few sand percentages and was subject to compression and high temperature, which helped In reducing the entry of water and its vulnerability inside the sample, which led to reducing the internal corrosion of the sample. It was noted that the fourth sample, the bricks, were not subjected to corrosion in the second experiment (outside the laboratory), because the sample does not contain sand, and the soil that constitutes it has been fermented and exposed to pride and a substance of dyes has been added on its surface to protect it from corrosion.

Table (4-2) Samples weight before and after the second exposure to acid rain

Sample name	Sample weight after first exposure	Sample weight after second exposure	Amount of exposure	Amount of erosion
Solid block	25.905 Kg	25.635 Kg	55.5L	0.270 Kg
Hollow block	21.245 Kg	20.985 Kg	55.5 L	0.260 Kg
Bricks	2.480 Kg	2.475 Kg	55.5L	0.005 Kg
Tile	2.090 Kg	2.090 Kg	55.5 L	0.000 Kg

The highest percentage of internal corrosion and a decrease in the weight of the samples was in the second experiment outside the laboratory, because they were exposed to natural factors such as wind, sun rays and rain in which acidic percentages, because the research was conducted in the period from (1/2 to 1/3) in which the samples were exposed to various factors The natural matter which increased the internal corrosion of the samples, except for the dyed brick sample, which did not have any corrosion due to the materials of its manufacture and because of the outer layer of copper pigments, which prevents water from permeating into the sample and not retaining moisture, which led to protecting it from internal corrosion unlike the rest of the samples.

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Table (4-3) comparison between results of weights before and after treatment

material	Before treatment	After first treatment	After second treatment
Solid blocks			
Hollow blocks			
Bricks			
Tile			

Conclusions

1- It was found through the study that the corrosion that occurred in the samples (hollow block, solid block, normal brick, brick) as a result of exposure to acid rain was recorded in the first experiment inside the laboratory compared to the control samples.

2- The results of the study showed a greater increase in the amount of corrosion of the samples in the second experiment outside the laboratory compared to the experiment inside the laboratory, and the environmental weather factors had a clear impact on this corrosion.

3- The study showed the varying corrosion of the brick sample inside and outside the laboratory, because it was coated with a layer of dyes consisting of a mixture of brass, lead and sand.

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4- The more severe the environmental factors such as rain, wind and heat, the more this will have an effect on accelerating the corrosion process in various building materials.

Recommendations

1_ To relatively reduce the effects of acid rain, it is recommended to paint buildings and homes with special dyes.

2_ Conduct studies on which of the following materials are most affected by acid rain (cement, gravel, gravel, sand) and thus control their quantities during the preparation of building materials.

3_ Reducing the effects of pollution, which plays the main role in the formation of acid rain, which includes (sulfur oxides, nitrogen oxides and others).

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