



Sultanate of Oman

Ministry of Education

General Directorate of Education in Al Dakhiliyah Governorate

Um Hani School for Basic Education (7-12)



The Effect of Mixing Sewage Sludge with Cement and Its Effect on Treating Building Cracks

Prepared by:

- Sundus bint Yahya Al-Jalandi – Grade 9
- Azza bint Rabeel Al-Daghishi – Grade 9

Supervised by:

- Ms. Nawar bint Mohammed bin Khalfan Al-Rawahi

March 2025

Contents

1. Abstract
2. Key Terms
3. Research Questions
4. Introduction & Literature Review
5. Research Methodology
 - Research Plan
 - Study Location
 - Data Collection and Analysis
6. Results
7. Discussion of Results
8. Conclusion
9. Acknowledgments
10. References

The Effect of Mixing Sewage Sludge with Cement and Its Effect on Treating Building Cracks

Prepared by:

- Sundus bint Yahya Al-Jalandi – Grade 9

- Azza bint Rabeel Al-Daghishi – Grade 9

Sultanate of Oman

Abstract

This research aims to study the effect of mixing sewage sludge with cement and its role in treating cracks in building walls. The study explores the following key questions:

1. What is the effect of mixing sewage sludge with cement used in construction?
2. What role does the resulting mixture of sludge and cement play in addressing cracks in building walls?

The results indicate that the addition of sludge alters the properties of cement, transforming it into a highly viscous solution. While there was a slight increase in salinity and conductivity, the pH value of the cement decreased after mixing with sludge. The difference in acidity between the cement sample and the sludge was (10.71 – 6.02 = 4.69) respectively, and then the acidity of the cement after mixing it with the sludge reached (10.08).

Gradually, different amounts of sludge were added to the cement. This had a clear effect in increasing the viscosity of the cement and obtaining a very thick product. It was observed that the mixture absorbed the amount of water added gradually to the mixture. The more water we added, the more the mixture dried out because of the intense absorption after adding the sludge.

This makes researchers recommend adding sludge to cement used in construction to enhance its moisture absorption capacity, potentially reducing the occurrence of cracks in buildings.

Key Terms

Sewage Sludge: The semi-solid residual material remaining after wastewater treatment from municipal or industrial sources. It contains organic and suspended solids and is considered a byproduct of the treatment process. (https://ar.wikipedia.org/wiki/%D8%AD%D9%85%D8%A3%D8%A9_%D8%A7%)

D9%84%D8%B5%D8%B1%D9%81_%D8%A7%D9%84%D8%B5%D8%AD%D9%8A, retrieved on 2/17/2025)

The Ministry of Environmental Protection defines sludge as the thick, viscous organic mixture of suspended solids remaining after the sewage treatment and pumping process is completed. (<https://www.gov.il/ar/pages/sludge>, retrieved on 2/17/2025)

Research Questions

1. What is the effect of mixing sewage sludge with cement used in construction?
2. What role does the resulting mixture of sludge and cement play in addressing cracks in building walls?

Introduction & Literature Review

Have you ever noticed cracks in your home's walls? Have you ever wondered if these cracks indicate the potential collapse of your house? Wall cracks, particularly external ones, can worsen if left untreated, potentially leading to structural failure. Various factors contribute to wall cracks, including errors during construction, exposure to environmental conditions, and natural disasters such as earthquakes and volcanic activity.

One significant factor leading to cracks is humidity, which can cause internal and external fractures. Other factors influencing a building's lifespan include thermal expansion and moisture absorption. (<https://www.bayut.com/mybayut/ar/%D8%AA%D8%B4%D9%82%D9%82%D8%A7%D8%AA-%D8%AC%D8%AF%D8%B1%D8%A7%D9%86-%D8%AE%D8%B7%D9%88%D8%B1%D8%AA%D9%87%D8%A7-%D9%85%D8%B9%D8%A7%D9%84%D8%AC%D8%AA%D9%87%D8%A7/>, retrieved on 1/3/2025)

Because the issue of building cracks is a common problem in reality related to the environment and general climate, in this research we experimented with mixing sludge from sewage waste with cement used in covering the outer layer of the house and using it to treat building cracks. We also studied the effect of mixing on the properties of cement in terms of studying acidity, conductivity and salinity using the tools and protocols of the GLOBE environmental program.

Research Methodology

1. Research Plan

This study followed a structured research plan, including data collection and experimental analysis using water and soil measurement protocols. The research team assigned roles, reviewed relevant literature, and implemented environmental

measurement tools to assess changes in cement properties when mixed with sewage sludge.

Research Timeline

Table (1) Research plan timetable

Task	Assigned Student	Month
Defining the research problem	Sundus	November 2024
Site visit and data collection	Azza & Sundus	December 2024
Data analysis and writing	Azza & Sundus	February 2025
Translation into English	Azza (with teacher's assistance)	March 2025
Participation in local exhibitions	Azza & Sundus	March 2025
Participation in international exhibitions	Azza & Sundus	April 2025
Final submission for competition	Azza & Sundus	April 2025

2. Study Location

The study was conducted in Samail, Al Dakhiliyah Governorate, Oman.

GPS Coordinates: 23.16.49 N, 58.02.17 E



Images (1) Geographic maps to locate the search

3. Data Collection & Analysis

1. What is the effect of mixing sewage sludge with cement used in construction? A sample of sewage sludge was obtained from the Samail Wastewater Treatment Plant. The sludge was ground into powder and analyzed using soil acidity, salinity, and conductivity measurement protocols before and after mixing with cement.

2. What role does the resulting mixture of sludge and cement play in addressing cracks in building walls?

Direct experimentation was conducted to observe moisture absorption levels in the sludge-cement mixture.

Data collection methods:

- Taking a sludge sample from the sewage treatment plant of Namaa Water Services Company in the Wilayat of Samayil, and applying the water and soil protocol to measure the acidity, salinity and conductivity protocols of the sludge and cement sample.

- Repeating the measurements three times to ensure the accuracy of the results

- Mixing a sample of sludge with cement and applying the soil protocol to the mixture and recording the salinity, conductivity and acidity data to know the effect of mixing on the properties of cement.



Image (2) The researchers apply acidity and conductivity protocols to the samples.

Mixing was done according to the soil protocol, and the magnetic mixing capsule available in the school laboratory was used.



Image (3) Magnetic mixing capsule used in mixing sludge with cement

The sludge was also mixed with distilled water in the same way as being used as a control experiment and compared with the experiment of mixing sludge with cement.

Results

Hydrological characteristics data for the water used in the protocols

Table (3) Data for the water used

Ph	Acidity Ppm	Conductivity µs
8.16	868	1230

Soil protocol data applied to the studied samples

Table (4) Data on acidity, salinity and conductivity of samples

Sample	pH	Conductivity (ms)	Salinity (ppm)
Sewage Sludge	6.02	5.46	3.82
Cement	10.71	4.09	2.84
Sludge + Cement	10.08	4.84	3.36

* The average values of three readings were recorded in each protocol.

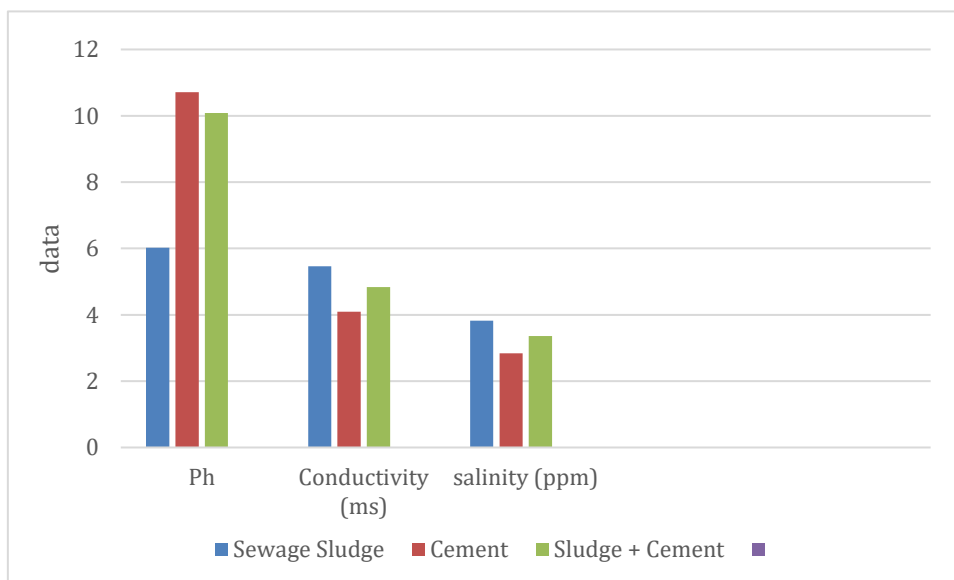


Photo (4) data of pH, conductivity and salinity of samples

Through the results, we noticed the following:

- The properties of cement (acidity, salinity, conductivity) change after adding sludge and mixing it with cement. The acidity decreased slightly, while the salinity and conductivity increased slightly.

- The sludge solution forms a very viscous substance, absorbs a large amount of water, and adding sludge to the cement solution contributes to the absorption of moisture very clearly. It may require adding More water was added to obtain the solution and take the necessary measurements. Water was added several times gradually. Sludge is highly absorbent of water, so after adding it to the cement, the mixture was able to absorb the amount of water measured according to the soil acidity protocol, and it was necessary to add more water in successive batches until a solution was obtained that was easy to measure and apply the protocol.

Data was entered and sent to the program website (www.GLOBE.gov) via the DATA ENTRY application, where a new work site was added and data collected through the search was entered.

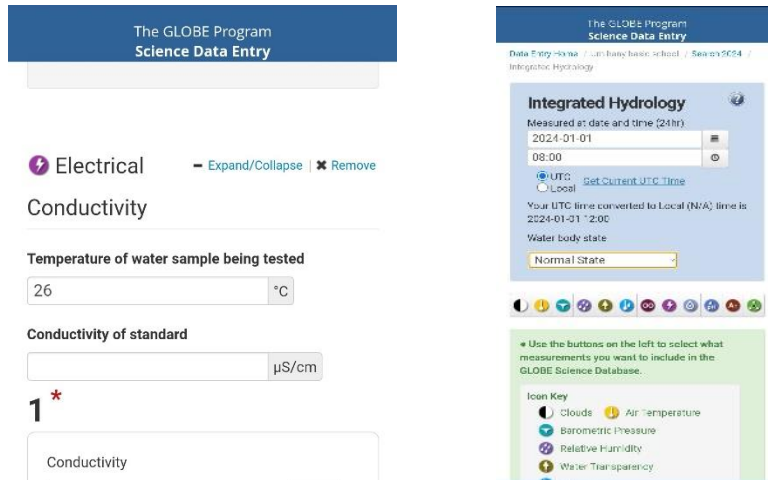


Image (5) Images for entering data into the site

Discussion of results:

From the data collected, we noticed that the properties of cement used in construction can change after mixing with sludge, as it turns into a highly viscous solution and acquires slight increases in salinity and conductivity.

While the pH value decreased after mixing the sludge with cement. The difference in acidity between the sludge sample and the cement was $(10.71 - 6.02 = 4.69)$ and then the acidity of the cement after mixing reached (10.08) .

Different amounts of sludge were gradually added to the cement, this had an effect It is clear in increasing the level of viscosity of cement and obtaining a very thick product. It was observed that the mixture absorbed the amount of water added gradually to the mixture. The more water we added, the more the mixture dried out as a result of the intense absorption after adding the sludge. This result is very inspiring. We all know the effect of moisture on the cement used in construction, as it is considered one of the causes of cracks. Cracks in the walls that appear in the ceilings or walls of the house require attention due to their danger. And distorting the aesthetic appearance, especially cracks in the external walls that may worsen if not treated and may lead to the collapse of the building. Therefore, mixing sludge with cement can be a useful source in absorbing the moisture that buildings may be exposed to continuously, which helps us in treating the cracking problem. Accordingly, the research team decided to start experimenting with a mixture of sludge and cement on one of the walls of buildings under construction. There is no doubt that the observation process will take a long time, from several months to years. We ask God for ease and success.

Conclusion

Using water and soil measurement protocols, this study confirmed that mixing sewage sludge with cement alters its acidity, salinity, and conductivity while also significantly increasing moisture absorption. Given that moisture absorption is a leading cause of cracks in buildings, this study suggests that blending sludge with cement could enhance its ability to absorb humidity, thereby reducing the likelihood of cracks in structures.

Acknowledgments

We extend our deepest gratitude to:

- T. Nawar Al-Rawahi, for her invaluable guidance.
- Umm Hani Basic Education School Administration, for their support.
- Nama Water Services, for providing sludge samples.
- GLOBE Environmental Program, for enabling data collection and participation in international research initiatives.

References

(<https://www.gov.il/ar/pages/sludge>, Retrieved 2/17/2025)

Bayut: Causes & Treatment of Wall Cracks (<https://www.bayut.com>)

GLOBE Environmental Program (www.GLOBE.gov)

GLOBE Environmental Program Technical Office, (2012). GLOBE Program Teacher's Guide

GLOBE Environmental Program Technical Office, (2012). Soil Protocol Study in the GLOBE Environmental Program

GLOBE Environmental Program Technical Office, (2012). Water Protocol Study in the GLOBE Environmental Program

Wikipedia: Sewage Sludge (https://ar.wikipedia.org/wiki/حمأة_الصرف_الصحي)