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EXTENDED ABSTRACTS

Cadmium Elimination Feasibility Study Using Bentonite Modified Green Concrete

Elham Asrari*, Mohammad Amin Nejabat

Faculty of Civil Engineering, University Payam Noor of Shiraz, Iran

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1. Introduction

Cadmium is a heavy metal with many environmental degradation effects that is available in various industries. Considering the use of concrete as the most expensive construction materials, this study investigates the removal of heavy cadmium metal by concrete modified with bentonite. Bentonite, as a clay absorber from the clay family, has a Monte Morillonite. Bentonite has good absorption properties as well as good mixing with concrete materials. In recent years, the use of various wastes, including glass and bricks in concrete, has been greatly appreciated. In this study, the construction and testing of green mixing concrete (concrete in accordance with the plan for the use of recycled materials and reducing environmental damage) using recyclable glass and brick materials. This concrete has non-structural standard concrete properties with bentonite. Green mixing concrete has the property of removing cadmium, one of the most hazardous materials and heavy metals. It is a concrete for use with various constructional concrete, and especially industrial sewage ponds.

2. Methodology

In this research, the construction of concrete with renewable building materials was used as a waste (green mixing concrete) to remove heavy metal cadmium. The materials used in this concrete are glass and bricks (100% instead of stone materials), and cement, water, and bentonite are used as a sorbent (for the adsorption of heavy metal cadmium) in this concrete. In order to achieve the aggregation of the above materials, different mixing designs were used and tested. Finally, in optimal design, a glass (of security type) with a maximum gravity of 15 mm as aggregate and bricks with a grain size of 0 to 5 mm were selected as fine aggregates. After determining the optimal mixing plan, the materials were prepared according to the same concrete design. After making and treating the concrete samples and placing them in the laboratory conditions, the samples were adjacent to different concentrations (10 to 100ppm), as well as different contact times (30 min to 1440 min) and different pH (2 to 10) and Of course, with a dose of resistance absorbents (0 to 15%). It should be noted that every time a sample was taken as a controlled pH. The solution was also prepared by 0.1 molar chloride acid and 0.1 molar yield and used in different intervals. Finally, with standard solutions (1, 3, 5 and 10), the initial and final sewage absorption was measured by atomic absorption spectrometry and the percentages of adsorption and optimal amounts were analyzed. All of these steps were carried out in high-precision laboratory conditions at 25°C.

*Corresponding Author
Email addresses: elasrari@yahoo.com (Elham Asrari), nejabat1984@gmail.com (Mohammad Amin Nejabat).

3. Results and discussion

In this study, the important parameters (adsorbent dose, pH, contact time, initial concentration of cadmium metal) were determined to determine the optimum conditions for cadmium adsorption with modified concrete with bentonite. Thus, in each step, a parameter was kept as a variable, and other parameters were kept constant. By repeating tests and comparing numbers, each parameter was optimized. Investigating the effect of pH in the cadmium adsorption process to determine the pH of the solution by assuming a fixed number of initial concentrations (50) as well as contact time (1 hour) and adsorbent obtained from the mixing plot (8%) in the sample concrete in solution 250 ml). The effects of pH concentration in different intervals (2, 4, 6, 8 and 10) were investigated under laboratory conditions and temperature of 25°C. As a result, the highest adsorption rate was observed at pH 6 and was 77.79%.

In order to study the effect of time in the cadmium uptake process, after obtaining a pH of 6 in the previous test steps, and also having a dose of 8% concrete, mixing the sample and maintaining the initial concentration (50), to investigate the effect of the contact time of the solution In the interval (30, 60, 120, 240, 360, 480, 720 and 1440 minutes). After making the standard solution of the cadmium calibration chart and carrying out an atomic absorption test, the maximum absorption was observed at 1440 min and 97.62%. It should be noted that the time from 6 hours to 24 hours did not significantly increase in the adsorption rate. Considering that in the pools of calmness of the refineries, the storage life of the wastewater is 4 to 6 hours. Thus, the optimum absorption time is 6 hours, with an absorption percentage of 40/97.

In order to obtain the initial concentration, the solutions of 10, 25, 50, 75, and 100mg / l of cadmium were first applied at the contact time of 6 hours, and the pH was equal to 6, and the absorbent dose was 8%. Samples were analyzed using atomic absorption numbers. As a result, the highest adsorption was observed at a concentration of 50mg / L and absorption of 86.20%. In order to find the optimum percentage of absorbent concrete, concrete made in the initial mixing scheme was used. According to the important parameters of concrete such as (strength, slump, or concrete stress, the required concrete performance), the percentages (2, 5, 8, 10 and 15) were tested. Then, the optimal absorption percentage was evaluated with actual concrete conditions of 8%. According to the results, the amount of solvent for bentonite was 15%, with an absorption percentage of 98/14%. The reason for using and optimizing adsorbent 8% for work is due to the effect of adsorbent in optimized concrete, which has an acceptable effect on the main parameters of the concrete. Therefore, for the experiment with actual wastewater, the dose of bentonite absorbent was applied at 8%. To formulate the traditional first-order and second-order adsorption charts for cadmium metal with pH = 6, the initial concentrations of the pollutant were 50mg / L and at 30 minute intervals. Based on the results, it was observed that the adsorption trait followed the higher pseudo-second-order equation (R2 = 0.9693). In the design of absorption systems, one of the important parameters is absorption isotherm, which results in interpreting the interactions between absorption and the object. Freundlich and Langmuir are commonly used to obtain this. Based on the results, it was observed that the adsorption isotherm had a higher permeability coefficient (R2 = 0.9741) from the Freundlich model.

In order to examine the sample absorption rate with actual wastewater, having all the main parameters of the absorbance (pH, contact time, solution concentration and absorbent dose), and the sample was subjected to the actual sample, industrial wastewater generated from the wastewater treatment plant of Shiraz Industrial Township Company. Became It should be noted that, according to a test on real sewage, it was found that sewage contains 5mg / l heavy metal cadmium. Due to the low concentration of heavy metal cadmium in the laboratory, this level of contamination was 50mg / L and in contact with the specimen under laboratory conditions and temperature of 25°C, numbers and optimal values of absorption parameters were introduced. After making the standard solution and using the cadmium calibration graph, the numbers were read and observed by atomic absorption of the actual sample of 99.88%.

4. Conclusions

The purpose of this study was to construct concrete with the ability to remove heavy metals in industrial and environmental conditions. The use of this concrete makes it more economical and efficient at industrial wastewater treatment and, of course, in optimal conditions. In the study of the effect of glass type on the strength of the concrete, in this study, three types of glass (construction mix, glass bottle and securite) were used as waste. Stainless steel glass with a good thickness and, of course, good grain size, has higher resistance (118kg / cm2) and was used as a glass for mixing. In research conducted in 2004 on glass, the results showed that the structure and thickness of the glass play an important role in determining the resistance and hardness ... (Wolfram Hyezeh, 2004). The type of brick used plays an important role in the strength of concrete. In this research, a mixture of building bricks were used as waste and as fine-grain materials. Also, the bricks were very good adhesion to other concrete materials and with good mental health of the concrete in the optimal design. With good compressive strength, the bricks retained concrete properties, and, with proper absorption, improved the absorption process. Although bricks have less compressive strength than concrete in concrete. In this study, the effect of solvent on the resistance of the samples was investigated. According to the results obtained from the compressive strength test of concrete, before and after contact with a solution containing cadmium metal, the strength of the concrete after contact with the laboratory solution containing cadmium was reduced by about 13%. Also, the resistance of the concrete in adjacent to the actual wastewater solution increased by about 9%. The reason for reducing the strength of concrete in the presence of a laboratory solution containing cadmium is the concentrated effects of the presence of cadmium metal and the effects of metal chemicals on concrete. Increasing the strength of concrete in a real industrial wastewater solution can be due to the sewage sludge adhesion, which causes the molecules to stick and approach. In the research, it was found that in the presence of heavy metal contamination, the compressive strength of the concrete decreased. The main reason for this was the cement loading in the presence of heavy metal oxides. (Rajab Pour Ashkiki et al., 2006). Time is one of the most important parameters as a result of a test, which is a good choice in the type of treatment method, as well as the economics of the project and the amount of absorption. The results showed higher adsorption rates over time. In this study, it was allowed to remove the heavy metal in concrete for half an hour, but the optimal time was 24 hours. However, considering the use in relaxation ponds, which allowed for about 4 to 6 hours to be allowed to leave the sewage system, as well as the lack of absorption differences between 6 hours and 24 hours, the optimal time of 6 hours was considered. The reason for the increased absorption process was the greater absorption of bentonite to absorb heavy metals. As we know, pH is one of the most important factors in the removal of metals in solutions. Indeed, in aqueous solutions, the ionization of adsorbent groups is controlled by the pH of the solution. (Gupta, 2016). In a study on the removal of heavy metals from cadmium by clay minerals, research has shown that the use of coprolite clay at pH 5 was greater than 4 and had a higher absorption efficiency. (Simaeifard, 1394). In this study, the effects of pH in the interval (2 to 10) were optimally eliminated by the number 6, but according to the results, it was determined that the environment moves as much as acidity or gaming relative to the neutral environment. The removal efficiency is reduced. In the study of the effect of adsorbent dose of bentonite, the adsorbent was used in the experimental range of 0 to 15% adsorbent, with the highest absorption percentage of 15. However, due to the closeness of the removal efficiency, and indeed the important parameters affecting the performance of the concrete, the optimum adsorbent percentage was assumed to be the same as the 8% assumption. In fact, the higher the absorbance was, the higher the absorption efficiency. With increasing adsorbent, the percentage of concrete strength decreased. In this study, in the study of the effect of initial concentration on cadmium elimination, the initial concentration range was between 10 and 100mg / L, which according to bentonite absorbent had the highest absorbance at 50mg / L concentration. The higher the concentration or the lower the concentration, the absorption process somewhat fell. Although in low concentrations, due to the low levels of contamination, the absorption process was better, it appeared that this concentration was low, which according to the results of this study, this number was about 50 milligrams. The capacity of absorption and concentration of cadmium solution play an important role in the final absorption rate.

5. References

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