

“CO₂ Absorbing Concrete Roads”

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ABSTRACT:

An experimental investigation was carried out to evaluate capacity of concrete roads to absorb carbon dioxide using natural zeolite (NZ). To overcome serious climate change, deep reduction in CO₂ emission will be required in next coming years. Global warming can be control by the CO₂ absorption technique. Global warming is caused by large greenhouse gases(CO₂, NH₄, etc.) emission by human activities. In construction sector, CO₂ emission dominantly occurs from cement production. Capturing of CO₂ from source, from polluted air and reducing atmospheric CO₂ concentration by using Zeolite material and Zeolite sand. Concrete roads with Zeolite as coat can absorb large quantity of CO₂.By coating Zeolite material on the concrete roads absorbs CO₂ from the atmosphere hence it will be eco-friendly as well as beneficial to the environment. Absorb CO₂ and reduces the air pollution, Keep environment clean and full of oxygen. Zeolite.This material is easily available.The direct partial replacement of cement by zeolite resulted in the slight decrease of compressive strength, especially the early strength and tensile splitting strength. Study of effect of zeolite on the strength of concrete made in this study by Choosing M30 Grade of Concrete and Replacement of Cement With 25% of zeolite and Also Project Conducted Compressive Test and Acid Attack Test.

Keywords-Experimental Study, Absorption, CO₂, M40 Concrete, Zeolite

I. INTRODUCTION

Zeolites occur naturally but are also produced industrially on a large scale. As of September 2016, 232 unique zeolite frameworks have been identified, and over 40 naturally occurring zeolite frameworks are known. Every new zeolite structure that is obtained has to be approved by the International Zeolite Association Structure Commission and receives a three letter designation It is also possible to produce zeolite structures that do not appear in nature. Zeolite A is a well-known example. Since the principal raw materials used to manufacture zeolites are silica and alumina, which are among the most abundant mineral components on earth, the potential to supply zeolites is virtually unlimited Zeolites are widely used as ion-exchange beds in domestic and commercial water purification, softening, and other applications. In chemistry, zeolites are used to separate molecules (only molecules of certain sizes and shapes can pass through), and as traps for molecules so they can be analyzed. Zeolites are also widely used as catalysts and sorbents. Their well-defined pore structure and adjustable acidity make them highly active in a large variety of reactions. Zeolites have the potential of providing precise and specific separation of gases, including the removal of H₂O, CO₂ and SO₂ from low-grade natural gas streams. Other separations include noble gases, N₂, O₂, Freon and formaldehyde.

II. HISTORY

On-board oxygen generating systems (OBOGS) and Oxygen concentrators use zeolites in conjunction with pressure swing adsorption to remove nitrogen from compressed air in order to supply oxygen for aircrews at high altitudes, as well as home and portable oxygen supplies

Global warming resulted from the emission of greenhouse gases has received widespread attention. Among the greenhouse gases, CO₂ contributes more than 60% to global warming because of its huge emission amount. The CO₂ concentration in atmosphere now is closed to 400 ppm which is significantly higher than the preindustrial level of about 300 ppm. To mitigate global warming, Kyoto Protocol urges 37 industrialized nations and European Union to reduce their greenhouse gas emissions to a level of 5.2% on average lower than those of 1990 during the period of 2008 to 2012. Copenhagen Accord also requests the global temperature increase be limited to 2°C above the pre-industrial level by 2100. International Energy Agency (IEA) pointed out to achieve the ± 2°C goal, CO₂ capture and storage (CCS) technology is required and the contribution would be 19% in 2050. It is therefore essential to develop the CCS technologies to cope with the global demand of CO₂ reduction. Among these technologies, chemical absorption using aqueous alkanolamine solutions is proposed to be the most applicable technology for CO₂ capture before 2030.

III. MATERIALS AND TESTING

The increase in the strength of mortars due to the replacement of zeolites 1Carbonation Of Concrete Carbonation is known to improve surface hardness, strength, and durability of cement-based products by porerefinement of the cement paste matrix. Carbonation can be helpful in non-reinforced cement-based products. However,for reinforced cement-based products, as the pH of carbonated cement paste reduces due to carbonation, reinforcingsteel loses its passivity and becomes vulnerable to corrosion. Carbonation in cement-based products can be defined as areaction between the CO₂ dissolved in water and the cement hydration product Ca(OH)₂ in the pore water. Thisreaction produces calcium carbonate (CaCO₃) and water. Calcium silicate hydrates and calcium aluminate hydrates also react with CO₂ in the presence of moisture to produce calcium carbonate and hydrates of silicates and aluminates andwater.CO₂ diffuses through the pores depending upon the pore structure and the degree of saturation of the pores in thecement paste matrix. CO₂ in gaseous phase does not react with cement hydration products; it has to dissolve in the porewater first to form carbonic acid (H₂CO₃). Out of the hydrates in the cement paste, the one which reacts with CO₂mostreadily is Ca(OH)₂. Other hydrates also react with dissolved CO₂, and hydrated silica, alumina, and ferric oxide areproduced. When all Ca (OH)₂ becomes carbonated, the pH value of the pore solution is reduced from 12.5 to 8.3

ZEOLITES

Zeolites are framework silicates, with a completely linked framework of tetrahedra, each consisting of 4 O₂-surrounding a cation (usually Si⁴⁺ or Al³⁺). The framework contains open cavities in the form of channels and cagesChannels and cages are occupied by H₂O molecules and extra-framework cations (K⁺, Na⁺, Ca⁺ and others) thatare commonly exchangeable. Channels are large enough to allow passage of guest species.In the hydrated phases, dehydration occurs at temperatures 400oC and is largely mostly below 400 C reversible Zeolites are porous, hydrated aluminosilicates. They may be natural minerals orsynthetic materials. The general chemical composition of a zeolite is:

Characteristics of Zeolite

- High degree of hydration
- Low density and large void volume when hydrated.
- Stability of the crystal structure when dehydrated.
- Cation exchange properties
- Uniform molecular-sized channels in dehydrated crystals.
- Ability to absorb gasses and vapors
- Catalytic properties

Properties Of Zeolites

The properties of zeolites are closely related to both structure and chemistry. Three main characteristic properties:

- Adsorption
- Ion exchange
- Catalytic activity

IV. PROBLEM STATEMENT

We hear a lot about carbon dioxide when we talk about climate change, but sometimes it's important to go back and examine why too much CO₂ in the atmosphere is a bad thing.

CO₂ a naturally occurring gas that is also emitted at great levels by human activity — is one of several greenhouse gases in our atmosphere. Other greenhouse gases include water vapor, methane, ozone, nitrous oxide and halocarbons. To understand the impact of these gases, we first start with the sun, which sends solar radiation in the form of light to Earth. The atmosphere deflects some of this radiation, while the rest hits the planetary surface and warms the land and oceans. The Earth then radiates its own heat back up in the form of infrared rays. Some of those rays escape the atmosphere, while others are absorbed and then re-emitted by the atmospheric gases. These gases – the greenhouses gases – then help to keep the planet at its normal temperature. For millions of years, the production of greenhouses gases was regulated by the natural systems of the planet. Gases would be absorbed and emitted at a fairly steady rate. Temperatures, meanwhile, were maintained at a level that supported life around the world. The Environmental Protection Agency characterizes this as "a balancing act."

V EXECUTION METHODOLOGY

Preparation of specimen

Preparation of mortar (plain concrete) specimen was accomplished following JIS (Japan Industrial Standards) A 1132-20067): "Method of making and curing concrete specimens,"

Which is equivalent to ISO1920-3:2004. Three identical specimens were prepared at a time. Mortar pieces were chosen in order to simplify the experiment for CO₂ absorption observation.

Cement mostly used was ordinary Portland cement. Water/cement ratio was 50 %. Porosity of the pieces was prepared at 0, 25 and 50 % void with using a foaming agent (Fine foam 707,

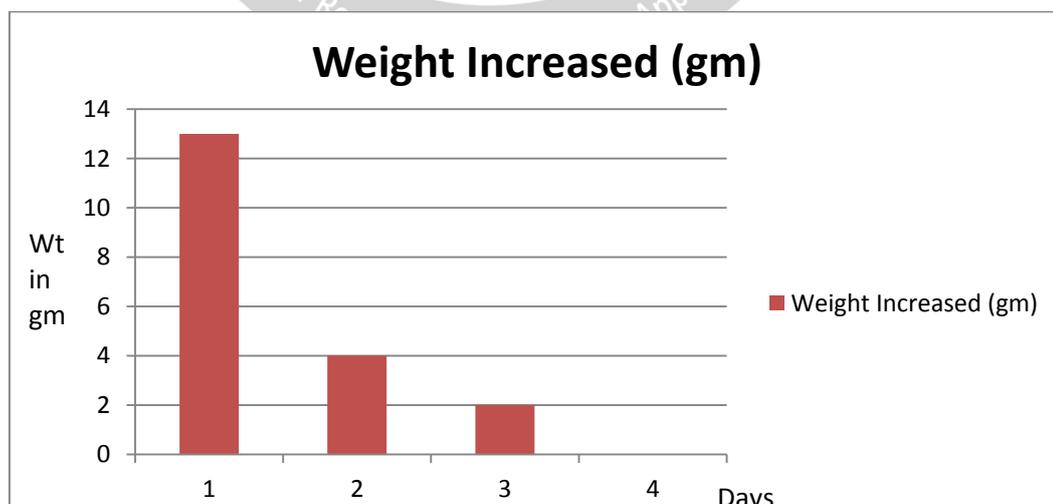
BASF). For all specimens, the amounts of aggregate and water were 1350 and 225 grams, respectively. Cure was done for 20 days in water at temperature $7 \pm 1^\circ\text{C}$ and drying under atmosphere at temperature $20 \pm 1^\circ\text{C}$ with relative humidity 65 %. The configuration of the piece was $40\text{mm} \times 40\text{mm} \times 160\text{mm}$. Two samples were used in the bending and compression tests and the other one was tested for a CO₂ absorption process

Reaction-



Experimental procedure

Pure carbon dioxide gas was introduced into a container of $300\text{ mm} \times 300\text{ mm} \times 500\text{ mm}$ to establish the atmosphere that contained CO₂ at 3 volumetric %. The concentration was measured with a digital carbon dioxide checker (CD-1, Fuso Co. Ltd., Tokyo, Japan). Then a mortar test piece was set in the container and the CO₂ content was continuously measured until the concentration became below the detection limit of 0.04 %. The experiment was repeated until total experimental time reached 100 hours.



Model



VI RESULT AND DISCUSSION

The graph shows that there is increased weight of zeolite with CO₂. And there is no effect of gas on strength of block prepared by zeolite sand and powder as a substitute. Hence this can be utilized without any problem in the buildings. The zeolite block can be used in the road pavements, Chimney of factory as well as at the faces of building. The Zeolite is costly material hence only small substitution by it would make it affordable for the people. The zeolite is available in abundant amount. This can also be manufactured. As CO₂ is causing too many problems which is leading to the heavier pollution effects like greenhouse effect, Environmental imbalance. The CO₂ plays major role in this. Hence it is very important to reduce its percentage from the environment. CO₂ is in gas form hence it will directly come in contact with construction built around. Apart from that construction industry contribute 70% of the total CO₂ expelling. As while cement production and at the time of curing of the structure it will get evolved into atmosphere. Hence it is very important to reduce its emission. This material will definitely reduce its emission. Hence it must be used in the construction.

VII. CONCLUSION

The recent trends in technologies are leading to tremendous increase in pollution. Hence it is need of time to reduce the pollution otherwise consequences will be devastating. The zeolite made concrete is capable of absorbing CO₂ without any emission of it. Otherwise general concrete evolve huge amount of CO₂ into the atmosphere. The zeolite of bottle of size 10 cm dia and 12 cm height has ability to absorb around 1 to 14 gm of CO₂ in 5 days. This property does not lose its strength and durability. Hence it can be used at any place without any doubt.

Advantages

- It absorbs the CO₂ from the surrounding environment and helps to stop the air pollutions.
- It gives more durability as well as great performance against ordinary Portland cement concrete.
- The presence of olivine material in the concrete increases the strength.
- The addition Zeolite has important advantages: Improves mechanical strength to the cement and stops emission CO₂.

REFERENCES

- [1] S. Subash¹, G. Sasikumar², V. Praveenkumar³, V. R. Karthikeyan⁴ & Er. K. Jegan Mohan⁵ "Partial Replacement of Zeolite with Cement" Vol-2, Issue-5, ISSN: 2454-1362 (2016)
- [2] Edith M. Flanigen, Robert W. Broach, and Stephen T. Wilson "History of Zeolite and organization" Vol III, 2008
- [3] Vivian W. Y. Tam "Evaluation Analysis of the CO₂ Emission and Absorption Life Cycle for Precast Concrete in Korea" 21 April 2016
- [4] Mia HIRATA*¹ and Itaru JIMBO "Utilization of Concrete Waste to Capture CO₂ with Zeolite" Mar. 29, 2016
- [5] Carbon dioxide Capture & Storage Ahmad Ghanis⁰⁴⁰⁷⁴⁴ Denmark Technical University Bachelor chemical and biotechnology 2009
- [6] Tiana Milović¹, Miloš Šešlija², Slobodan Šupić³, Suzana Vukoslavčević "INFLUENCE OF NATURAL ZEOLITE ON SOME PROPERTIES OF MORTAR/CONCRETE" DOI:10/ 2015
- [7] T. Subramani¹, J. Karthickrajan². "Experimental Study On Absorption Of CO₂ By M30 Concrete As A Partial Replacement Of Cement By 25% Of Zeolite" Volume 5, Issue 5, May 2016
- [8] P. Frontera¹, S. Marchese¹, F. Crea¹, R. Aiello¹ & J. B. Nagy² "The strength effects of synthetic zeolites on properties of high performance concrete"
- [9] Balraj More, Pradeep Jadhav, Vicky Jadhav, Giridhar Narule, Shahid Mulani "