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PRELIMINARY STUDY ON USE OF TERRAZYME AS A BIO STABILIZER ALONG WITH CEMENT AND LIME IN COMPRESSED STABILIZED EARTH BLOCKS

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Abstract

Stabilizers play an important role in improving the engineering properties of the Compressed Stabilized Earth Blocks (CSEBs).Traditional stabilizers like cement and lime have been popularly used to improve the soil with which CSEBs are prepared. It has been reported that use of lime in combination with cement has improved the long-term strength of CSEBs. Due to the high energy consumption in manufacturing of conventional stabilizers, alternative sources of stabilizers are looked upon. Terrazyme is one such stabilizer, which has been used in various road projects and has found to be a viable low cost non-traditional stabilizer. The use of Terrazyme as a stabilizer, may have a beneficial role in increasing the strength of CSEBs. As no previous attempts have been made to use Terrazyme in the preparation of CSEBs, it was found that understanding its behavior with soil as a necessary. Time related physical properties of a natural soil treated with Terrazyme has revealed that liquid limit reduces with time, while plastic limit increased with ageing. The reduced plasticity index indicates that the soil is becoming less compressible and volumetrically stable. Unconfined compressive strength of soil treated with different dosages of Terrazyme at ageing periods were evaluated, and optimum dosage for the soil was arrived. Addition of Terrazyme has increased the unconfined compressive strength of the soil. Unconfined compressive strengths of soil with/without optimum dosage of Terrazyme along with combinations of cement and lime with time were evaluated. The admixtures-soil combination which yielded the best Unconfined Compressive strength was selected for the preparation of CSEBs. Blocks prepared with Terrazyme had higher wet compressive strength and lower water absorption than other blocks. After two months, the wet compressive strength of blocks prepared with Terrazyme was found 30% to 50% higher than the blocks without Terrazyme, bringing out the beneficial effect of Terrazyme.

Keywords:

Terrazyme, Blocks, Enzymes, Compressive Strength.

1 INTRODUCTION

Soil stabilization is an important process in improving the engineering properties of the soil. Previously, this was achieved by addition of popular stabilizing agents like cement or lime. Recent technological developments have led to the invention of innovative stabilizing agents. Stabilization by the addition of bio-enzyme is an innovation, which in recent past has given economical solutions for stabilizing sub-grade material in road construction [Rajoria and Kaur 2014]. This technology of enzymatic stabilization was initially used in improving the soil conditions for horticultural purposes [Velasquez et al 2005]. With its revolution in soil stabilization, many bio enzymes have been developed based on this technology. One such product is Terrazyme, which has been extensively used in developing countries for modifying the sub-grade soils in road construction. Being low in cost, easy to transport, and relatively having wide applicability as compared with traditional stabilizers, make Terrazyme an economical stabilizing agent.

As Terrazyme helps in effective stabilization of soil, its utilization in preparation of sustainable building materials would be beneficial. Amongst the variety of soil stabilizers used, cement has been the most popular stabilizer in the manufacture of Compressed Stabilized Earth Blocks (CSEBs). Attempts have been made by various researchers in the past to document the role of cement as a stabilizer in CSEBs. Being a popular stabilizing agent, cement has been extensively studied to understand its role in preparation of CSEBs [Spence 1975; Venkatarama Reddy and Jagadish 1989; Venkatarama Reddy 1991; Houben and Guillaud 1994; Walker and Stace 1997; Kerali 2001;

Venkatarama Reddy and Walker 2005]. Attempts to independently utilize lime instead of cement in the preparation of CSEBs and compare their properties with those prepared with cement has been reported in the literature [Guettala et al. 2002; Raheem et al. 2010; Miqueleiz et al. 2012]. Recently, Nagaraj et al. [2014] have brought out the efficacy of using lime in combination with cement in improving the long-term strength of CSEBs. This study is an attempt to explore the possible beneficial utilization of Terrazyme in small quantity along with an optimum combination of lime and cement in preparation of CSEBs.

2 ROLE OF STABILIZERS IN CSEBS

Stabilization is a process of mixing admixtures with soil to improve its volume stability, strength, permeability and durability [Bell 1993]. Stabilization is considered to be an important process in the manufacture of CSEBs, and is aimed at improving the performance of a soil as a construction material. Amongst the variety of soil stabilizers used, cement has been the most popular stabilizer in the manufacture of CSEBs. Attempts have been made by various researchers in the past to document the role of cement as a stabilizer in CSEBs [Spence 1975; Venkatarama Reddy and Jagadish 1989; Venkatarama Reddy 1991; Houben and Guillaud 1994; Walker and Stace 1997; Kerali 2001; Venkatarama Reddy and Walker 2005]. However, compared to cement, utilization of lime as a stabilizer in the preparation of CSEBs has not found popularity. Lime has been used in stabilizing clayey soils, and has been found to impart long-term strength gain as reported in the literature [Bell and Coulthard 1990; Little 1995; Mallela et al. 2004; Amu et al. 2011; Herrier et al. 2012] An outstanding testimonial of the durability of the lime-stabilized soils is the Friant-Kern irrigation canal in California as reported by Herrier et al [2012].

In the recent past, attempts to independently utilize lime instead of cement in the preparation of CSEBs and compare their properties with those prepared with cement has been reported in the literature [Guettala et al. 2002; Raheem et al. 2010; Miqueleiz et al. 2012]. Guettala et al. [2002] have tried to use various quantities of lime namely, 5%, 8% and 12% to improve the durability of the blocks. The evaluated dry strength of blocks reported by them is around 9.4, 14.2 and 16.2 MPa respectively for 5%, 8% and 12% of lime. Similarly, when tested under humid state, the strength of the blocks was found to be 4.4, 8.2 and 9.8 MPa respectively for 5%, 8% and 12% lime. From their study, it is clear that after an optimum value of lime content, any further increase in lime will not be so beneficial in the strength gain of the blocks. Raheem et al. [2010] have reported the 28 days wet compressive strength of compressed stabilized interlocking earth blocks prepared with lime and cement alone as stabilizers added in varying quantities from 5% to 25%, with an increment of 5%. For maximum amount of stabilizer content, namely, 25%, the strength gain of the blocks is found to be 3.2 MPa and 1.2 MPa for blocks prepared with cement and lime respectively.

Very recently Miqueleiz et al. [2012] have reported the advantage of using lime towards the development of unfired clay bricks. From the results of tests conducted on cylindrical specimens of 65 mm diameter and 30 mm height prepared with use of 18% lime, they have found that, at the end of 90 days of ageing the maximum compressive strength of the cylindrical specimens was nearly 13 MPa, and the strength of cylindrical specimens prepared with 18% of cement were around 18 MPa. Very recently Nagaraj et al. [2014] have reported the effectiveness of utilizing lime in combination with cement in the preparation of CSEBs. They have observed that blocks prepared with optimum quantity of lime along with cement has led to continuous buildup of strength even beyond 2 years, whereas blocks prepared with cement alone and lesser quantity of lime than optimum quantity have not gained much strength after 6 months from the time of preparation of the blocks. Further, they have reported the use of stabilizers in combination would help in reducing their quantity in the preparation of blocks of comparable strength to that prepared with cement alone. This would be added benefit not only in reducing the cost of the blocks, but also has serious implications in terms of the reduction of energy consumed in the manufacture of blocks when done in large scale.

3 TERRAZYME AS A BIO STABILIZER

3.1 Enzyme Soil Stabilization

Enzymes have a catalytic effect for the stabilization of the soil. The mobility of the enzymes depends on the pore fluid that enables them to be transported to any given reaction site in the soil. On reaching the specific reaction site, the enzymes are adsorbed by the clay lattice and are released upon the exchange of cations [Velasquez et al 2005]. Thus in theory, the enzymes are active in a soil until there is no more reactions exist to catalyze. Thus they are required in small dosages for stabilization purposes [Tingle et al. 2007]. Scholen [1992] also proposed that the enzymes could bond with large organic molecules that would be attracted to the clay minerals' net negative surface charge. The large organic molecules would then surround the clay minerals, neutralizing the negative charge and reducing the clay's affinity for moisture. The end result of both proposed mechanisms is a more stable clay lattice structure and a reduced affinity for moisture.

3.2 Terrazyme - Bio Stabilizer

Terrazyme is a bio-enzyme in liquid form used as a non-traditional soil stabilizer is formulated using vegetable extracts. The use of bio enzymes has gained popularity due to its effectiveness in soil stabilization. Organic enzymes come in liquid form. They are perfectly soluble in water, brown in colour and smell of molasses.

Terrazyme is specially formulated to modify the engineering properties of soil. They require dilution in water before application. Terrazyme acts to reduce the voids between soil particles and minimize absorbed water in the soil for maximum compaction. This decreases the swelling capacity of the soil particles and reduces permeability. The application of Terrazyme enhances weather resistance and increases load bearing capacity of soils [Ravishankar et al. 2009].

Tab. 1: Physical Properties of the Natural Soil and Sand used in the present study

	Specific Gravity, (Gs)	**Atterberg Limits**				**Free Swell Test**			**Particle Size Distribution**				
		w_L	**w_P**	**I_P**	**w_S**	**Water**	**Kero-sene**	**Free Swell Ratio**	Gravel (%)	Sand (%)	Silt (size) (%)	Clay (size) (%)	**Group Symbol**
Soil	2.62	42	23	19	21	12	10	1.2	2	60	27	11	SC
Sand	2.63	-	-	NP	-	-	-	-	2	93	5	-	SP-SM

4 EXPERIMENTAL PROGRAMME

4.1 Materials

In the present study, locally available red earth, sand, ordinary Portland cement, lime and Terrazyme were used for the preparation of CSEBs. It was ensured that the selected soil was air dried, pulverized to break the clods and sieved through 20mm sieve. Ordinary Portland cement of 53grade used in the study conformed to requirements of Bureau of Indian Standard [IS: 12269 1987]; while lime conforming to technical guidance of Bureau of Indian Standard [IS: 712 1984] was used. The selected soil was characterized for its physical properties namely, liquid limit, plastic limit, shrinkage limit, particle size distribution, sediment volume and specific gravity using the standard procedures as specified by Bureau of Indian Standards (BIS), and the results are summarized in Table 1. Free Swell Ratio as defined by Prakash and Sridharan [2004] has been used as a simple method of identifying the presence of principal clay mineral in the soil. For the soil used in this study, is non-expansive in nature as inferred from FSR value, being 1.2, indicating kaolinite as the dominant clay mineral. The same has been reported in Table 1.Sand was tested for its specific gravity and particle size distribution, and the results are reported in Table 1.

The OPC cement was tested for its fineness, normal consistency, initial setting time and specific surface area as per Bureau of Indian Standards.

4.2 Proportioning of Natural soil with Sand

Based on the extensive works carried out by various researchers, it has been shown that proper grading increases the density of the blocks, which in turn improves their compressive strength [Spence, 1975].

Tab. 2: Proportions of constituents present in natural and modified soil used in the present study

Constituent	**Percentage fractions present in natural soil**	**Percentage fractions present in reconstituted soil**
Sand	60.0	69.1
Silt (size)	29.0	22.4
Clay (size)	11.0	8.5

As a guideline, the best possible combination of ingredients would be 70 % of sand and gravel, and 10 to 20 % clay for obtaining good wet compressive strength of blocks [Olivier and Mesbah 1987; Houben and Guillaud 1994;Venkatarama Reddy and Jagadish, 1995]. Hence, the sand content of the reconstituted soil was maintained around 75% and clay content less than 15% (refer Table 2).

4.3 Determination of Optimum Dosage of Terrazyme

As no technical standards have been established, its applicability relies on empirical guidelines set on previous studies [Velasquez et al. 2005]. Varying dosages of the enzyme have different effects on the same soil, arriving at optimal dosage of Terrazyme would be beneficial. Insufficient quantity of enzyme would not yield effective stabilization, while higher quantities may prove to have adverse effects on soil [Ravishankar et al. 2009]. Researchers in the past have tried to understand the applicability of enzyme with different soil types. Bergmann [2000] concluded that bio-enzymes require some clay content in the soil in order to create the enzymatic reactions. Successful stabilization could be achieved with as little as 2 percent clay, and the best result would to achieve for soils having clay with 10-15 percent. Issac et al. [2003] has found that Terrazyme was found useful in improving CBR properties for clays and sands, while it was found to be less significant for silty soils. Manoj et al. (2003), assessed the suitability of soil stabilizer on five types of soils with varying clay content and found that soils with moderate to high clay content has improved stabilization effect. Ravishankar et al. [2009] reports to medium improvement in soil physical properties and not effective in improving CBR properties for soil containing higher percent of cohesionless material.

In order to arrive at the optimum dosage of Terrazyme based on the physical properties and strength characteristics of the natural soil used in the present study, the following dosages presented in Table 3 were considered. In the following section, details of the experimental programme planned for evaluating the physical properties and strength characteristics is presented.

Tab. 3: Dosages of Terrazyme used in the present study

Sl.No	**Dosage Notation**	**200ml/ "x"m^3 of soil**	**ml/kg of soil**
1	ST1	3.5	0.025
2	ST2	2.5	0.039
3	ST3	2.0	0.050
4	ST4	1.5	0.065

In order to arrive at the optimum dosage of Terrazyme, natural soil was treated with different dosages and tested for its physical and strength properties at different ageing periods namely 7, 15, 28 and 60 days. Fig 1 presents the plot of variation of Atterberg limits versus ageing period.

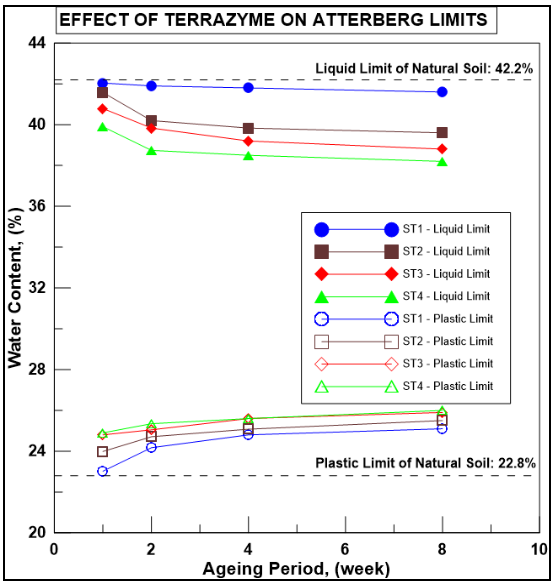

Fig. 1: Effect of Terrazyme on Atterberg limits at different ageing periods

Two sets of identical soil specimens were prepared and tested for unconfined compressive strength with the dosages mentioned in Table 3. The soil specimens to be used for strength testing were wrapped with a piece of cotton cloth and stored in desiccators filled with water at the bottom to maintain constant humidity. One set of prepared specimens were cured with daily application of water up to required ageing period, and another set of specimens were just stored in desiccator with the cotton wrapped on the specimen without being supplied with water till the desired ageing period. Unconfined Compressive strength for both cured and uncured conditions different dosages were also determined for different ageing periods namely 7, 15, 28 and 60 days. Fig 2 presents the plot of variation of unconfined compressive strength versus ageing period.

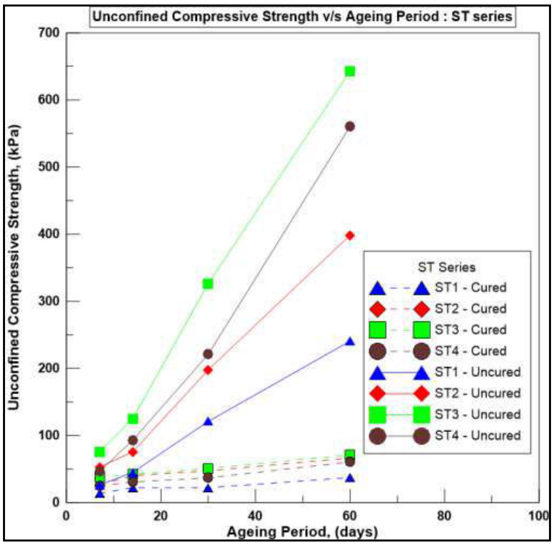

Fig. 2: Unconfined Compressive Strength of soil versus ageing periods for dosages of Terrazyme

Based on the results obtained from the tests, the optimum dosage for the natural soil was found to be 0.050ml/kg.

4.4 Effect of Terrazyme on strength characteristics of soil along with traditional stabilizers

In order to understand the behavior of Terrazyme along with traditional stabilizers, namely, cement and lime, the following experimental programme was planned. Based on the test results obtained from the effect of Terrazyme on physical properties and strength characteristics of the soil, the optimum Terrazyme dosage when it is used was obtained. This optimum Terrazyme dosage was kept constant for further part of the experiments.

Based on the previous research findings by Nagaraj et al. [2014] who have reported that the use of lime and cement in combination has a beneficial effect in imparting better strength to CSEBs, various combinations of lime and cement were chosen as tabulated in Table 4. Here the total amount of conventional stabilizers was maintained at 8 percent.

To understand the role of Terrazyme along with the conventional stabilizers, UCC samples were prepared with and without Terrazyme.

Tab. 4: Proportions of stabilizers used in the preparation of unconfined compressive strength

Series Name	Soil (%)	Cement, (%)	Lime (%)	Terrazyme (0.05ml/kg)
SP1	92	8	0	-
SP2	92	6	2	-
SP3	92	4	4	-
SP4	92	2	6	-
PT1	92	8	0	√
PT2	92	6	2	√
PT3	92	4	4	√
PT4	92	2	6	√

Fig. 3 is plot of unconfined compressive strength versus ageing for various proportions of stabilizers used in this study. The maximum unconfined compressive strength of specimens achieved at end of 60 days for proportion PT2 (6% Cement and 2% Lime with optimum dosage of Terrazyme) is nearly 4.7 MPa, followed by the specimens prepared with PT1 (8 % cement with optimum dosage of Terrazyme) and PT3 (4 % cement and 4 % lime with optimum dosage of Terrazyme) proportions, exhibiting UCC strengths of 4.3MPa and 3.5MPa respectively. Further, it can be observed that, the specimen with proportion PT3 having lesser cement content than proportion SP1 (8 % cement alone)was able to achieve higher unconfined compressive strength. This observation brings out the effectiveness of Terrazyme in imparting strength to the soil, which would help in reducing the cement content when used as a stabilizer in CSEBs. The reasons for this increased unconfined compressive strength for proportions with optimum dosage of Terrazyme may be attributed to the effect of Terrazyme on soil by better aggregation and cementation, leading to decreased pore content in the soil. This aspect is further supported by reduced water absorption values of UCC samples. Thus, combined use of cement and lime along with small quantities of Terrazyme, has found to be beneficial in imparting higher strength to the soil specimens.

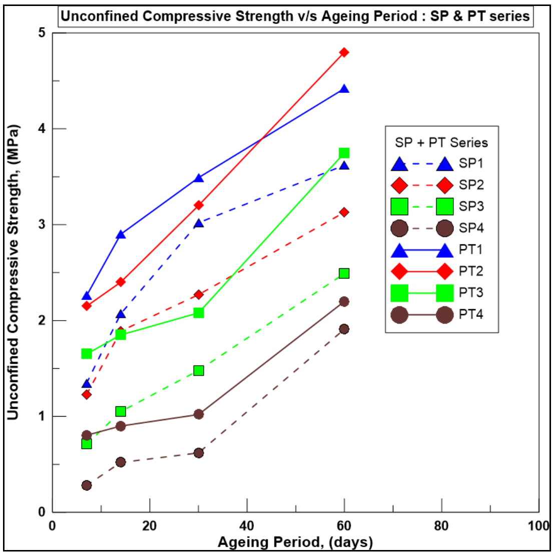

Fig. 3: Unconfined Compressive Strength of soil for different proportions of cement, lime and Terrazyme versus ageing periods

4.5 Preparation of Compressed Stabilized Earth Blocks (CSEBs)

The test results obtained from unconfined compressive strength of soil specimens stabilized with different proportions of terrazyme, cement and lime provided a guideline for potential use of terrazyme in preparation of CSEBs.

Recent research findings reported by Nagaraj et al [2014] indicate that the blocks prepared with combination of cement and lime had beneficial effect in imparting strength of CSEBs. It was reported that there was continuous development of strength for the blocks prepared with optimum content of lime in combination with cement, while blocks prepared with only cement ceased to develop further strength after 6 months of preparation. In order to take advantage of long-term beneficial effect of lime and short-term strength gain by using cement, two proportions of cement and lime in combinations were considered in preparation for CSEBs. To further the effectiveness of Terrazyme when used in combination of cement and lime in improving the strength of the CSEBs, blocks were prepared with combination of cement and lime without and with Terrazyme, which are mentioned in Table 5

Tab. 5: Proportions of stabilizers used in the preparation of Compressed Stabilized Earth Blocks

Series Name	Soil (%)	Cement, (%)	Lime (%)	Terrazyme (0.05ml/kg)
SB2	92	6	2	-
SB3	92	4	4	-
BT2	92	6	2	√
BT3	92	4	4	√

The size of the blocks prepared using Mardini press was 230 x 110 x 75 mm. The preparation process comprised of batching, mixing, placing the mix in the press, compaction and ejection of the blocks. The density of the blocks was maintained at 2.05 Mg/m^3. The required quantities (mass basis) of the ingredients namely, soil, sand, and the stabilizers (lime and cement) as obtained from the calculations depending on the series were weighed and initially mixed in a dry condition.

For making soil blocks, the proportioned dry mix was spread on big tray, and the calculated quantity of water was sprinkled to the mix and thoroughly worked with hand to have uniform distribution of moisture. Wet mixing was undertaken for further 2 to 3 minutes after the addition of water. For the blocks prepared using Terrazyme, the organic stabilizer was injected to the water prior to its application to the dry mix. Then the wet mix was transferred to the mould, placed in position on the Mardini press. The wet mix was remolded in the mould using a wooden mallet to give proper placement. The lid of the mould was closed and properly locked at the top. Using the toggle lever mechanism, the mix was pressed to give the designed compactive effort. The soil block was ejected from the mould by opening the top lid. The ejected block was weighed and serially labeled with date of preparation, date of testing and a suitable identification number (for the series adopted) (Plate 1) for ease of future identification. All blocks were prepared within 15 minutes of wet mixing. It was ensured to cure the blocks in shade and also by keeping them moist for a minimum period of 28 days. Sufficient number of CSEBs were prepared for evaluating their engineering properties, namely, wet compressive strength and water absorption for various ageing periods, namely, 7, 15, 30 and 60 days from the date of preparation

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Plate 1: View showing the labeled CSEBs for future identification

4.6 Testing of Compressed Stabilized Earth Blocks (CSEBs)

The CSEBs prepared as per the procedure described
above were tested for their wet compressive strength and water absorption for different periods of ageing reckoned from the date of preparation as per the prescribed procedures of Bureau of Indian Standards. The test procedures adopted are presented below. The results in this study are an average of test conducted on six numbers of blocks at each period of ageing.

Wet compressive strength of the CSEBs was determined according to Bureau of Indian standards [IS: 3495-1, 1992].Each block was prepared by filling the frog marks on the faces by 1:1 cement mortar and was cured for a day. These blocks were later immersed in clean water for 2 days in advance before the date of testing corresponding to ageing selected in the study. Later, the blocks were removed from water, and the surfaces were wiped dry and tested for their compressive strength using Universal Testing Machine (UTM). The load was applied at the rate of 2 N/mm^2/min. Plywood sheet of 3 mm thick was placed on either faces of the block before the application of load.(Plate 2)

Plate 2: View showing the testing of CSEBs for its Wet Compressive Strength

Water absorption on CSEBs was done as per Bureau of Indian standards [IS: 1725, 2000]. The blocks were dried completely in the oven and their mass was recorded accurately. The blocks were then immersed in water for 48 h. Later, the blocks were weighed again, and the increased mass was noted to determine their water absorption.

5 RESULTS AND DISCUSSION

5.1 Wet Compressive Strength

Fig. 4 presents the results of wet compressive strength of CSEBs prepared with different proportions of stabilizers at different ageing periods selected in this study. It can be observed that, at any given period of ageing, the wet compressive strength of CSEBs prepared with Terrazyme along with any selected proportion of conventional stabilizers used in this study, is found to be higher than that of wet compressive strengths of CSEBs prepared with only conventional stabilizers. With the small addition of Terrazyme, there is a noticeable increase in wet compressive strength for both proportions. The wet compressive strength achieved by BT2 and BT3 series blocks after 60 days of ageing is 3.8 and 2.8 MPa which is 30% and 50% higher than wet compressive strengths of SB2 and SB3 respectively. This increase in wet compressive strength may be attributed to the addition of Terrazyme at optimum dosage. The addition of Terrazyme might have probably have added benefit to the production of cementitious products. It may have helped the soil bacteria to release hydrogen ions, resulting in pH gradients at the surface of clay particles. This would assist the breaking up of the clay lattice [Velasquez et al, 2005]. In the presence of calcium ions released in the system from the added lime, the pH gradients would be further increased, which would assist in the breaking of clay lattice. This would have favored the release of more quantity of silica into the system, and in the presence of lime and cement would have led to the production of cementitious products contributing to increased strength of the blocks. Further, due to the presence of lime, the blocks may further show an increase in strength with time as reported by Nagaraj et al [2014] Also, it can be observed that the wet compressive strength for blocks of proportions BT3 and SB2 are comparable at ageing period of 30 and 60 days. This indicates that comparable strength of blocks could be achieved with reduced quantity of cement with slight addition of Terrazyme, thereby reducing the dependency on cement alone in the preparation of CSEBs.

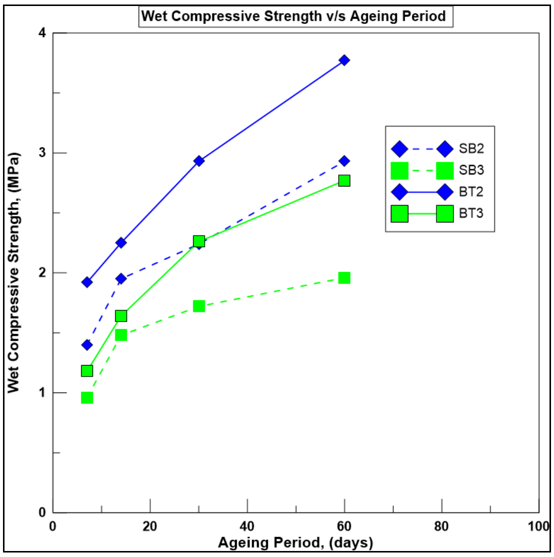

Fig. 4: Wet Compressive Strength versus ageing periods for all the proportions of CSEBs

5.2 Water Absorption

Fig 5 presents the results of water absorption versus ageing for all the proportions used in the preparation of CSEBs. From the figures, it can be observed that there is continuous decrease in water absorption values for all the specimens at all periods of ageing. At any given ageing period, it can observed that, for a given proportion of cement and lime, the water absorption values of CSEBs treated with Terrazyme are lesser in comparison with the CSEBs prepared without using Terrazyme. These changes are similar to those observed in UCC soil sample and may be attributed to the better interactions of Terrazyme with the conventional stabilizers, namely lime and cement. The addition of Terrazyme may lead to micro-level changes leading to better stabilization, while the interactions of cement and lime with the silicates of soil may lead to formation of cementations products, resulting in better cementation of the particles. This would probably block the interconnectivity between the pores, and hence, reduction in water absorption values. As per Bureau of Indian Standards [IS 1725 2000] for standard bricks, water absorption should be less than 15 %.

6 CONCLUSIONS

From this experimental study the effectiveness of Terrazyme as a stabilizer in improving the soil properties has been clearly brought out. On addition of Terrazyme to soil, the liquid limit reduced with time, while plastic limit and increased with time. This variation in Atterberg limits of soil resulted in decreased plasticity index with time indicating that, a clayey soil on being treated with appropriate dosage of Terrazyme, can be transformed into a less compressible soil with ageing. This would also imply that the Terrazyme treated soil becomes relatively more volumetrically stable.

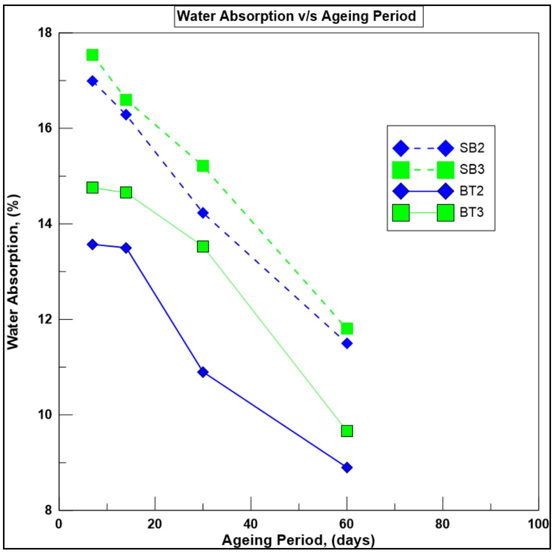

Fig. 5: Water Absorption versus ageing periods for all the proportions of CSEBs

The addition of Terrazyme has also improved the strength of soil indicating that the addition of Terrazyme in optimum dosage would enable to improve strength of the soil and also make it less compressible and volumetrically stable. Further, Terrazyme has showcased distinct effect in imparting strength along with cement and lime. It was found that there was proportional increase in strength for the soil treated with optimum dosage of Terrazyme along with cement and lime with ageing in comparison with untreated soils. Based on the tests results it can be concluded in certain that the application of Terrazyme in combinations with cement and lime would certainly aid in the preparation of CSEBs with desirable strength and optimizing the stabilizer content. CSEBS prepared with optimum dosages of Terrazyme along with conventional stabilizers was found to have higher wet compressive strengths and lesser water absorption values than CSEBs prepared with only conventional stabilizers. Further gain in strength of blocks can be expected with time due to the presence of lime. The values of wet compressive strength are quite good enough for construction of masonry structures.

The findings from this research study indicate that there is an immense potential of using Terrazyme as a viable low cost stabilizer along with cement and lime in preparation of CSEBs. Usage of Terrazyme in small quantities would probably help in reducing the dependency on cement alone as a stabilizer in manufacture of CSEBs. Being an novel approach, the research findings forms to be a guideline for utilizing Terrazyme as a viable low cost stabilizer in manufacture of CSEBs. Based on this encouraging results of utilizing Terrazyme along with conventional stabilizers, further study is in progress to ascertain the possible reduction in the quantity of stabilizers for preparing blocks of desirable strength and durability. When implemented on a commercial scale, this would help in reducing the quantity of conventional stabilizers, thereby increase the green rating of the blocks, and thus contributing to the development of sustainable building materials.

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