A Study on Improving the Strength Properties of Adobe Brick with the use of Agriculture Waste Stabilizer

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Abstract

The construction of adobe houses in flood prone areas is a common practice. These houses collapse when hydraulic loads from flood exerts on the houses. The failure occurs because the adobe brick lacks strength. In order to improve strength of adobe brick, the effects of agriculture waste therefore rice straw, rice husk and rice husk ash as a stabilizing agent have been explored in this paper. The compressive strength test and splitting test was conducted on the adobe specimens which were stabilized with 2% rice straws, 2% rice husk and 2% rice husk ash by the dry weight of soil. The results showed the improvement in strength and elasticity of specimens containing rice straws & rice husk. Whereas with the addition of rice husk ash, the adobe loses its strength and showed plastic behavior.

Keywords : flood, adobe brick, soil stabilization

1. Introduction

Adobe is a sun dried mud brick used to build earthen adobe house, especially in developing countries as these are approachable, cheap, environmental friendly and easy to build. Thus it is assumed that the usage of adobe brick for construction purpose will be continued in developing nations[1]. Earth is highly exposed to hydrological hazards, Guha-Sapir[2] reports in the annual disaster statistical review 2011 that approximately 57.1% of the total disaster victims in 2011 were the result of hydrological hazards, and of those hydrological hazards, 66.8% were triggered by floods. The report mentioned several Asian developing countries, where flooding frequently occurs. The weakness of adobe brick and the weak structural integrity makes the adobe houses highly susceptible to flood[3]. The hydraulic actions therefore hydrostatic and hydrodynamic actions of flood may induce the lateral forces on the vertical element of house (depends on the flow velocity and depth of water). If the severity of hydraulic actions is greater than the resistance capacity of house, the chance of damage will increase[4]. The lateral forces generate from flood exerts perpendicularly to the contacted vertical elements of house and may subject to lateral displacement and overturning failure[5]. Whereas the buoyancy forces may overcome the overall weight of house structure which increase the chances of floating[6]. The masonry or heavy weighted structure are at lower risk when buoyancy action acts on it. To increase the resistance of walls against the hydraulic loads, the strength of materials needs to be increased and the strength of adobe brick depends on the cohesion between soil particles[7]. To improve the strength of adobe brick, the stabilization of soil is necessary as it increases the cohesion in soil matrix[1]. In the past researches, the agriculture waste stabilizers showed positive contribution in improving the mechanical properties of adobe as it holds the soil particle and counteracts on the exertion of external loads[8,9]. The ratio of stabilizer to soil is an important factor, the use of excessive stabilizer in soil will reduce the quantity of soil which ultimately reduces the stress transmission with in the matrix and results to the decrease in strength[1]. Thus this paper investigates & compares the effects of natural stabilizers therefore, Rice straws, Rice Husk & Rice husk ash which were added in the soil by 2% of the dry weight of soil to maintain the cohesion between soil matrix.

2. Material Preparation

The soil used in this research consists of 48% sand & 52% fines. The specimens were prepared from the un-stabilized soil (S), Straw stabilized soil (SS), Husk stabilized soil (HS) & Ash stabilized soil (AS). These specimens were dried for 28 days under the sheds at 28 (+ 5) ° C temperature & 69 (+5) % relative humidity. Total of 20 prism specimens (5

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from each soil mixture) were prepared with height-width (H/W) ratio between 2-5 forthe compressive strength test & 20 cylindrical specimens (5 each soil mixture) were prepared with H/D ratio 2 for splitting test. Both tests were performed in compression testing machine on speed rate of 0.5-1.0 Mpa/min.

3. Experimental Results

3.1 Compressive strength

The test results as shown in the table 1 indicates, the (SS) and (HS) showed the positive results than the (S) and (AS). Comparatively the (HS) increases the compressive strength more than straw (SS), whereas in case of elasticity, (SS) is more elastic than (HS). The (AS) is observed to be more plastic and low in strength than (S) as it deformed in lowest displacement.

3.2 Splitting test

The results presented in table 1 indicates that the tensile strength reduced with the addition of husk. However, the effectiveness of stabilizers is determined by the material's failure under tensile loads as shown in figure 1. At the ultimate load, the wide shear crack appeared on (S) and (AS) which thus marked separation of specimen. From the results it is clear that the (AS) increased the tensile strength but the (AS) retains the plastic behavior as at the ultimate load the sudden and brittle rupture was observed. While SS and HS specimens exhibits fine columnar cracks on its height. The crack on specimens containing husk was broad but doesn't leads to the major detachment and the crack on the specimens containing straws was fine and thus no rupture was observed after the removal of load, which thus indicates the elastic behavior under the tensile load.

Table 1. compressive strength test & Splitting test results

Specimens	C (Mpa)	σc (Mpa)	CV (%)	Ɛc mm/mm	CV (%)	Ec (Mpa)	T (Mpa)	CV (%)
S	1.36	1.94	2.91	0.03	6.31	45.33	0.28	7.5%
SS	1.49	2.12	0.87	0.11	7.74	19.35	0.48	7.16%
HS	1.69	2.42	2.86	0.056	6.96	24.14	0.23	7.52%
AS	1.23	1.75	1.86	0.0099	6.67	136.6	0.30	6.44%

Note: C = compressive strength, σc= Failure stress, Ɛc = Failure strain, Ec= Modulus of elasticity, T = Tensile strength,

4. Conclusion

The observed effects of straw & rice husk is due to its long fiber and the pozzolanic properties respectively which creates the strong bonding in the soil matrix and results in efficient transfer of induced loads throughout the bulk of material. The rice husk ash on the other hand loses its cementation property. It could be because the ash for experiment was obtained by burning the husk in heap which exceeds the temperature and turned the silica from non-crystal to crystal form[10].

(S) (SS) (HS) (AS)

Figure. 1. Failure of specimens after splitting test

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