IMPROVE THE PROPERTIES OF OCHER

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ABSTRACT

Thinking about the friendly building material, such as unburnt bricks. If we do not have the burning step for this product processing, it is not only good for our environment, but also reducing the cost of bricks. Moreover, green solution – no smell and no colour admixture – is used in this research to improve the properties of ocher.

This paper shows the effect of green solution on the properties of ocher: determine the good mix proportion of ocher, compressive strength, bending strength, water absorption of ocher. The specimens with green solution and the specimens without green solution prepared to distinguish the desired effect of green solution.

After tested 72 serieses of specimens, the best amount of soil of weathered granite is 20% for mix proportion. Being used green solution, the strength of ocher is increased from 12% to 21%, the reducing ratio of water absorption is decreased from 8 % to 11%, The increasing ratio of saturation is from 2 % to 6 %.

Keywords: ocher, unburnt bricks, green solution

1. INTRODUCTION

The materials and technologies chosen for construction must, in addition to functional efficiency, fulfil some or more of the following criterion, for the cause of sustainability and a better quality environment: non endanger bio-reserves and be non-polluting; utilize locally available materials; utilize local skills, manpower and management systems; be accessible to the people; be low in monetary cost. [1]

Ocher are among the most widely used pigments. They can be traced back to the earliest cave paintings. Ocher can be found in natural form in volcanic regions. There are many variations of ocher: a light, warn tone is Venetian Red, darker, more cool-toned purple versions is called Indian Red, or Caput Mortuum. It is good for environment and our health to replace the burnt ocher bricks by unburnt ocher bricks.

2. EXPERIMENT

2.1. Materials

2.1.1. Ocher

In this research, there are 4 kind of materials was used: soil of weathered granite (SWG), burnt ocher (BO), east ocher (EO) and binder (B).

Table 1. Properties of materials

Materials	Diametter	Specific gravity (g/cm^3)	Bulk density (kg/dm^3)
SWG	< 1 mm	2.61	1650
BO	< 1 mm	2.58	1580
EO	$2700cm^2/g$	3.00	1150
Binder	$2700cm^2/g$	3.02	1150

Table 2. Chemical composition of binder

Oxide	SiO_2	Al_2O_3	CaO	Fe_2O_3	MgO	Ig. loss
Content, (%)	67	18	4	2	4	5

2.1.2. Green solution

Green solution is a kind of admixture that is no colour and no smell.

Table 3. Analysis test of green solution

Composition	Result	Specification	Test method
Arsenic As_2O_3	Not detected	Not more than 0.1 ppm	DDTC-Ag absorption photometry
Lead Pb	Not detected	Not more than 0.05 ppm	Atomic absorption photometry
Cadmium	Not detected	Not more than 0.1 ppm	Atomic absorption photometry
Mercury Hg	Not detected	Not more than 0.01 ppm	Atomic Fluorescence absorption photometry
Chrome	Not detected	Not more than 0.5 ppm	Diphenyl-carbarzide absorption photometry

2.2. Mix proportion

Table 4. Mix proportion [2]

Series	Materials (%)			
	SWG	DO	EO	B
III-5	15	45	15	25
III-6	15	40	15	30
VI-5	20	40	15	25
VI-6	20	35	15	30
IX-5	25	35	15	25
IX-6	25	30	15	30
XII-5	30	30	15	25
XII-6	30	25	15	30

SWG: soil of weathered granite, BO: burnt ocher, EO: east ocher and B: binder.

2.3. Test method

2.3.1. Strength of ocher

Base on the KS F 2329 : 1997, the cylinder diameter 5 cm, height 10 cm specimens was made for compressive strength, 4 x 4 x 16 cm was made for bending strength. [3]

2.3.2. Water absorption [4]

Water absorption greatly affects the durability of brick (measured by its resistance to frost action). Very soft, underburned bricks may absorb water as much as one-third of their weight; whereas good, hard bricks may absorb water less than 10 percent. The smaller the amount of absorption, the greater the durability. It is the saturation coefficient as defined in the following, is also a measure of freeze-thaw resistance. A large saturation coefficient indicates relatively fewer and smaller pores in the brick. The smaller voids accommodate expansion results from the freezing of water in the larger voids. In some consequence, bricks with a higher saturation coefficient are expected to have less resistance to damaging action from frost than units that contains a lower saturation coefficient. The absorption of specimen (total water absorption) is defined as the increase in the weight of specimen due to water. It can be expressed as a percentage of the dry weight, and can be calculated as

$$absorption \quad ratio = \frac{W_2 - W_1}{W_1} \times 100$$

The saturation coefficient, also called the C/B ratio, is defined as the ratio between absorption after 24 hours in cold water and absorption after boiling for 5 hours, and is calculated as

$$C/B = \frac{W_2 - W_1}{W_3 - W_1} \times 100$$

Where,

W_1: is the dry weight of the unit

W_2: the saturated weight of the unit after 24 hours submersion in water

W_3: the saturated weight of the unit after 5 hours submersionin boiling water.

3. RESULTS AND DISCUSSION

Table 5. Compressive strength and increasing ratio of ocher

Series	Compressive strength (MPa)				Increasing ratio	
	7 days, 0% GS	7 days, 1% GS	28 days, 0% GS	28 days, 1% GS	7 days	28 days
III-5	7.10	8.36	7.73	9.04	18	17
III-6	9.94	11.79	11.13	13.09	19	18
VI-5	8.37	10.13	9.21	10.92	21	19
VI-6	11.30	13.45	13.46	15.86	19	18
IX-5	7.40	8.75	7.81	9.12	18	17
IX-6	9.49	11.16	10.06	11.71	18	16
XII-5	6.74	7.82	7.14	8.20	16	15
XII-6	8.03	9.30	8.58	9.96	16	16

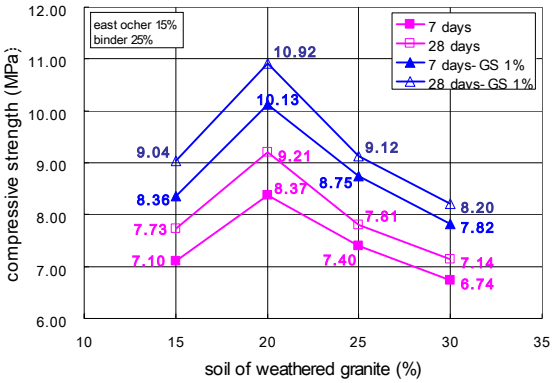

Figure 1. Variation of compressive strength due to green solution, 25% binder, east ocher 15%

Curing 7 days, 25% binder, compressive strength of series III-5 is 7.10 MPa without green solution and 8.36 MPa with 1% green solution (GS 1%). Compressive strength of series VI-5 is 8.37 MPa without green solution and 10.13 MPa with 1% green solution. Compressive strength of series IX-5 is 7.40 MPa without green solution and 8.75 MPa with 1% green solution. Compressive strength of series XII-5 is 6.74 MPa without green solution and 7.82 MPa with 1% green solution. Curing 28 days, compressive strength of series III-5 is 7.73 MPa without green solution and 9.04 MPa with 1% green solution. Compressive strength of series VI-5 is 9.21 MPa without green solution and 10.92 MPa with 1% green solution. Compressive strength of series IX-5 is 7.81 MPa without green solution and 9.12 MPa with 1% green solution. compressive strength of series XII-5 is 7.14 MPa without green solution and 8.20 MPa with 1% green solution. (Fig. 1)

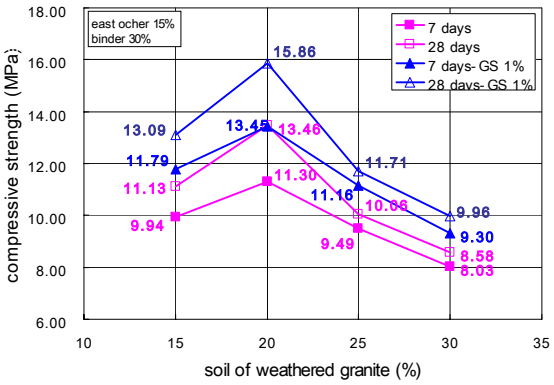

Figure 2. Variation of compressive strength due to green solution, 30% binder, east ocher 15%

Curing 7 days, 30% binder, compressive strength of series III-6 is 9.94 MPa without green solution and 11.79 MPa with 1% green solution (GS 1%). Compressive strength of series VI-6 is 11.30 MPa without green solution and 13.45 MPa with 1% green solution. Compressive strength of series IX-6 is 9.49 MPa without green solution and 11.16 MPa with 1% green solution. Compressive strength of series XII-6 is 8.03 MPa without green solution and 9.30 MPa with 1% green solution. Curing 28 days, 30% binder, compressive strength of series III-6 is 11.13 MPa without green solution and 13.09 MPa with 1% green solution. Compressive strength of series VI-6 is 13.46 MPa without green solution and 15.86 MPa with 1% green solution. Compressive strength of series IX-6 is 10.06 MPa without green solution and 11.71 MPa with 1% green solution. Compressive strength of series XII-6 is 8.58 MPa without green solution and 9.96 MPa with 1% green solution. (Fig. 2).

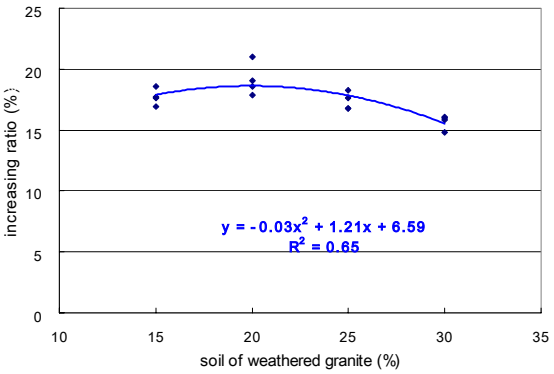

Figure 3. Increasing ratio of compressive strength by green solution

When green solution is used, the increasing ratio of compressive strength is from 16 % to 21 % after 7 days, and from 15% to 19% after 28 days. When soil of weathered granite is 20%, increasing ratio of compressive strength is higher than the other. (Fig. 3)

Table 6. Bending strength and increasing ratio of ocher

Series	Bending strength (MPa)				Increasing ratio (%)	
	7 days, 0% GS	7 days, 1% GS	28 days, 0% GS	28 days, 1% GS	7 days	28 days
I-5	0.50	0.58	0.66	0.76	16	15
III-6	0.70	0.81	0.95	1.10	16	16
VI-5	0.60	0.70	0.78	0.90	17	15
VI-6	1.00	1.12	1.20	1.41	12	18
IX-5	0.52	0.60	0.65	0.75	15	15
IX-6	0.62	0.72	0.81	0.94	16	16
XII-5	-	-	0.51	0.58	-	14
XII-6	0.60	0.69	0.73	0.84	15	15

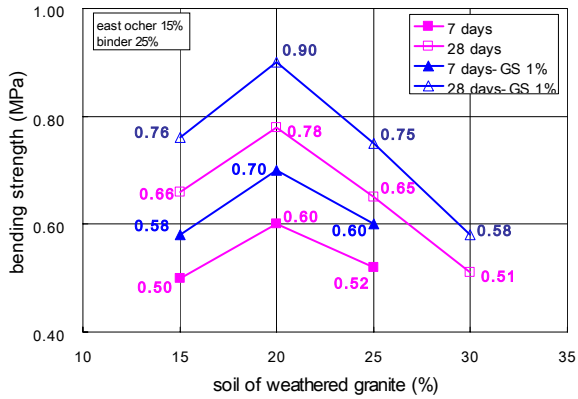

Figure 4. Variation of bending strength due to green solution, 25% binder, east ocher 15%

Curing 7 days, 25% binder, bending strength of series III-5 is 0.50 MPa without green solution and 0.58 MPa with 1% green solution. Bending strength of series VI-5 is 0.60 MPa without green solution and 0.70 MPa with 1% green solution. Bending strength of series IX-5 is 0.52 MPa without green solution and 0.60 MPa with 1% green solution. Bending strength of series XII-5 can not be determined. Curing 28 days, 25% binder, bending strength of series III-5 is 0.66 MPa without green solution and 0.76 MPa with 1% green solution. Bending strength of series VI-5 is 0.78 MPa without green solution and 0.90 MPa with 1% green solution. Bending strength of series IX-5 is 0.65 MPa without green solution and 0.75 MPa with 1% green solution. Bending strength of series XII-5 is 0.51 MPa without green solution and 0.58 MPa with 1% green solution. (Fig. 4)

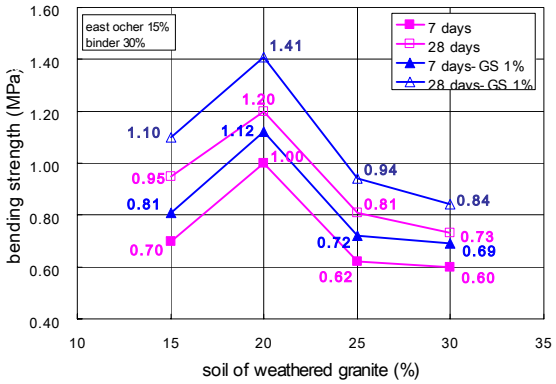

Figure 5. Variation of bending strength due to green solution, 25% binder, east ocher 15%

Curing 7 days, 30% binder, bending strength of series III-6 is 0.70 MPa without green solution and 0.81 MPa with 1% green solution. Bending strength of series VI-6 is 1.00 MPa without green solution and 1.12 MPa with 1% green solution. Bending strength of series IX-6 is 0.62 MPa without green solution and 0.72 MPa with 1% green solution. Bending strength of series XII-6 is 0.60 MPa without green solution and 0.69 MPa with 1% green solution. Curing 28 days, 30% binder, bending strength of series III-6 is 0.95 MPa without green solution and 1.10 MPa with 1% green solution. Bending strength of series VI-6 is 1.20 MPa without green solution and 1.41 MPa with 1% green solution. Bending strength of series IX-6 is 0.81 MPa without green solution and

0.94 MPa with 1% green solution. Bending strength of series XII-6 is 0.73 MPa without green solution and 0.84 MPa with 1% green solution. (Fig. 5)

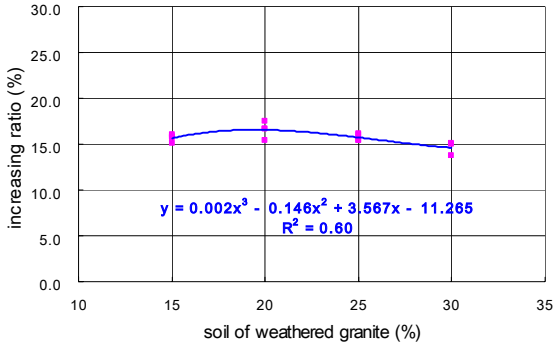

Figure 6. Increasing ratio of bending strength by green solution

When green solution was used, the increasing ratio of bending strength is from 12.00% to 17% curing 7 days, and from 14% to 18% curing 28 days. (Fig. 6)

Table 7. Variation of water absorption and saturation by green solution

Series	Water absorption			Saturation		
	0% green solution	1% green solution	decreasing ratio	0% green solution	1% green solution	Increasing ratio
III-5	16.80	14.99	11	88.92	91.86	3
III-6	14.53	12.94	11	91.55	95.34	4
VI-5	15.25	13.96	8	90.74	93.10	3
VI-6	14.32	12.70	11	92.78	98.11	6
IX-5	16.36	14.71	10	88.63	91.82	4
IX-6	14.52	13.15	9	90.79	94.40	4
XII-5	17.20	15.37	11	88.02	91.16	4
XII-6	15.58	14.32	8	89.80	91.38	2

Series III-5, 25% binder, water absorption is 16.80 % without green solution and 14.99% with 1% green solution. Series VI-5, water absorption is 15.25% without green solution and 13.96% with 1% green solution. Series IX-5, water absorption is 16.36% without green solution and 14.71 % with 1% green solution. Series XII-5, water absorption is 17.20% without green solution and 15.37% with 1% green solution. Series III-6, 30% binder, water absorption is 14.53 % without green solution and 12.94 % with 1% green solution. Series VI-6, water absorption is 14.32 % without green solution and 12.70 % with 1% green solution. Series IX-6, water absorption is 14.52 % without green solution and 13.15 % with 1% green solution. Series XII-6, water absorption is 15.58 % without green solution and 14.32 % with 1% green solution. (Fig. 7)

It is said that the structure of ocher that is added green solution is better than ocher without green solution. The pore in the structure of ocher is reduced because of the green solution.

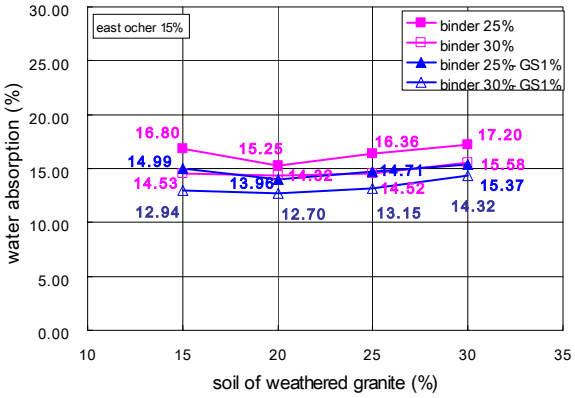

Figure 7. Variation of water absorption due to green solution, east ocher 15%

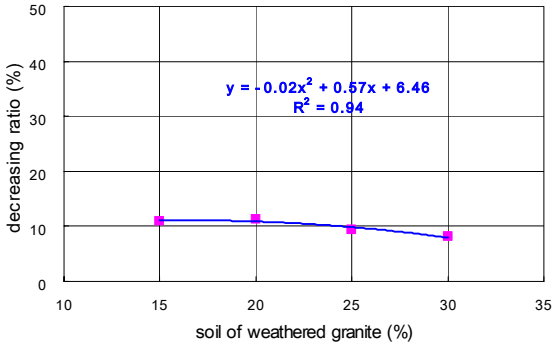

Figure 8. Decreasing ratio of water absorption by green solution

The decreasing ratio of water absorption, when green solution was used, is from 8 % to 11%,

Series III-5, 25% binder, saturation is 88.92 % without green solution and 91.86 % with 1% green solution. Series VI-5, saturation is 90.74 % without green solution and 93.10 % with 1% green solution. Series IX-5, saturation is 88.63 % without green solution and 91.82 % with 1% green solution. Series XII-5, saturation is 88.02 % without green solution and 91.16 % with 1% green solution. Series III-6, 30% binder, saturation is 91.55 % without green solution and 95.34 % with 1% green solution. Series VI-6, saturation is 92.78 % without green solution and 98.11 % with 1% green solution. Series IX-6, saturation is 90.79 % without green solution and 94.40 % with 1% green solution. Series XII-6, saturation is 89.80 % without green solution and 91.38 % with 1% green solution. (Fig. 8)

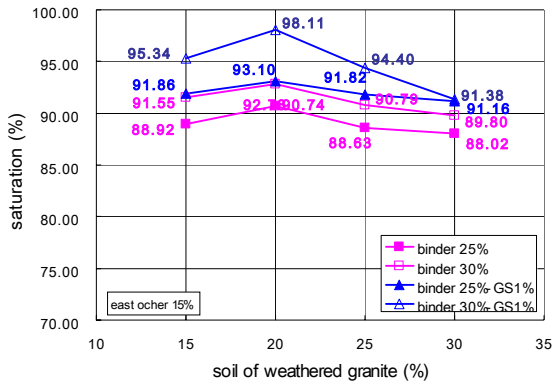

Figure 9. Variation of saturation due to green solution, east ocher 15%

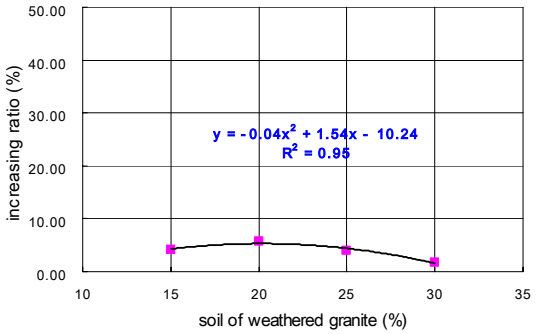

Figure 10. Increasing ratio of saturation by green solution

When green solution was used, the increasing ratio of saturation is from 2 % to 6 %. This is shown that the durability of the ocher becomes better when the green solution is used than ocher without green solution. (Fig. 9)

4. CONCLUSION

- ✧ We can add green solution to improve the properties of ocher. The ratio of compressive strength increases when green solution used is from 15% to 21%.
- ✧ The increasing ratio of bending strength is from 12% ~ 18%. The strength of ocher can compare to the strength of burnt bricks, especial when green solution was used.
- ✧ When green solution was added, the reducing ratio of water absorptionis reduces from 8 % to 11%.
- ✧ When green solution was added. The increasing ratio of saturation is from 2 % to 6 %.

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