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THE EFFECT OF BLOOD CLAM SHELL POWDER ADDITION ON SHEAR STRENGTH VALUE OF CLAY SOIL

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ABSTRACT

Ground condition is an important aspect that influences performance under the load. An effort to overcome the load problem can be done by improving unstable soil through soil stabilization using blood clam shell powder. In order to determine the shear strength and changes in its value, it can be done by conducting the Triaxial UU test on a mixture of clay and blood clam shell powder with addition of 10%, 20%, 25%, and 30% of soil weight and 4% coal ash. Mixed soil was then stored in plastic for 24 hours to achieve evenly distributed moisture content. Laboratory testing was carried out with reference to ASTM (American Society for Testing and Materials) standards, aimed to calculate soil shear angle, cohesion, and soil shear strength values. The results showed that the addition of blood clam shell powder and coal ash increased the soil shear strength compared to the clay soil (without any addition). The highest shear strength value of 35,724 kPa was obtained by adding 25% blood clam shells.

Keywords: Ash from Burning Bricks, Shear Strength, Blood Shells, Stability, Clay Soil

1. INTRODUCTION

High bearing capacity subgrade is a highly expected factor in structural planning because the structure strength will be directly affected by its ability to receive and transmit the load from the structure above it. In this study, soil stabilization was carried out using the chemical stabilization method with additional materials used for stabilization, namely blood clam shell powder (*Anadaragranosa*) and coal ash. Previous study carried out by Aziudin (2019) utilized blood clam shells with addition of 0%, 10%, 15%, 20%, 25%, and 30% of the weight of the expansive clay which was then applied to shallow foundations. The unconfined compression test showed that the addition of 25% blood clam shell

powder increased the value of the free compressive strength (qu) to the maximum point of 3,434 kg/cm^2. The research topic was soil stabilization test with blood clam shells adding 10%, 20%, 25%, and 30% of the soil weight and 4% coal ash which was then stored for 24 hours to achieve evenly distributed moisture content. Followed by the Triaxial Act (Unconsolidated Undrained) test American Society For Testing and Materials. (1999). Optimizing the utilization of shells and coal ash are expected to reduce waste and provide added value. This study aimed to perceive the effect of adding blood clam shell powder and coal ash to increase clay soil stability in terms of the Triaxial UU (Unconsolidated Undrained) test American Society for Testing and Materials. (2010c), and determine the best percentage of blood clam shell and coal ash as a stabilizer either to increase clay soil stability to get the highest soil shear strength value or to achieve the optimum stability value of clay.

2. METHODOLOGY

2.1. PREPARATION

1) **Soil Sampling**

   The clay samples used were taken from Tanjung Aur III Housing Area on Tanjung Barangan Street, Bukit Baru Village, Ilir Barat I District, Palembang City, South Sumatra. The grain size of the soil was 4.75mm (passed sieve No.4).

2) **Blood Clam Shell Sampling**

   Blood clam shells (*Anadaragranosa*) were the waste of the PecelLele& Seafood Apollo restaurant on Jenderal Basuki Rachmat Street, Pahlawan, Kemuning District, Palembang City, South Sumatra.

3) **Coal Ash Sampling**

   Coal ash was obtained from a brick kiln in Celikah Village, Raya Simpang Kijang Street, KijangUlu, KayuAgung District, Ogan KomeringIlir Regency, South Sumatra.

2.2. TEST ITEMS PRODUCTION

1) The clay samples used as a test object were dried under the sun. The tests carried out were:
   - Soil physical properties assessment include soil moisture content, Atterberg limits of plastic limit and liquid limit, and Specific gravity evaluation.
   - Soil mechanical properties assessment include Triaxial UU (Unconsolidated Undrained) test.
2) The cleaned blood clam shells were roasted for approximately 1 hour, then pounded with a pounder to produce powder and sieved using a No. sieve. 40 (0.425 mm).
3) Coal ash taken from the brick kiln was sieved using a No. sieve. 200 (0.075 mm).
4) Soil passed filter No. 4 was mixed with powdered shells, coal ash and distilled moisture.
5) Mixed test object was put into a plastic bag and then stored for 24 hours to achieve evenly distributed moisture content.

6) The amount of blood clam shell and coal ash was obtained from substituting the total amount of clay required for the Triaxial UU experiment according to the percentage of blood clam shell added and planned. Table 1

Table 1

Table 1 Shellfish Powder Addition				
Shell Variation	**Shell Weight**	**Ash Variation**	**Ash Weight**	**Clay Soil Weight**
0%	0	0%	0	2000 gr
0%	0	4%	80 gr	1920 gr
10%	200 gr	4%	80 gr	1720 gr
20%	400 gr	4%	80 gr	1520 gr
25%	500 gr	4%	80 gr	1420 gr
30%	600 gr	4%	80 gr	1320 gr

2.3. SOIL PROPERTIES INDEX ASSESSMENT. AMERICAN SOCIETY FOR TESTING AND MATERIALS, (2010D)

- Moisture content test (ASTM D2216: 2010).
- Filter analysis test (ASTM D6913-04: 2009).
- Atterberg limit test, Liquid limit (LL) (ASTM D4318-08: 2010).
- Specific gravity (Gs) test (ASTM D854-10: 2010).

2.4. SOIL MECHANICAL PROPERTIES ASSESSMENT

- American Society for Testing and Materials, (2010d)
- Soil compaction test (Standard proctor) (ASTM D698-12:2010)
- Unconsolidated Undrained Triaxial Testing (ASTM D2850-95: 1999)

3. RESULTS AND DISCUSSION

3.1. ASSESSMENT OF PHYSICAL PROPERTIES (INDEX PROPERTIES) AND MECHANICAL PROPERTIES OF SOIL (MECHANICAL PROPERTIES)

Evaluation of soil index properties was carried out to identify the soil. Soil index properties obtained were soil parameter values including moisture content, sieve analysis, Atterberg limits (liquid limit and plastic limit), and specific gravity. Mechanical properties of the clay soil were evaluated using soil compaction test (standard proctor) and Triaxial UU (Unconsolidated Undrained) American Society for Testing and Materials. (2010d). Table 2

Table 2

Table 2 Index Properties, Mechanical Properties, and Classification of Clay Soil		
No	**Soil Identifications**	**Results**
1	moisture Content (%)	41,67
2	Sieve Analysis	
	Passed through Sieve (%)	

	No. 4	99,020
	No. 10	96,120
	No. 20	92,498
	No. 40	88,416
	No. 60	83,820
	No. 80	78,544
	No. 100	71,620
	No. 200	54,306
3	Atterberg Limits	
	Liquid Limit (%)	57,24
	Plastic Limit (%)	28,63
4	Specific Gravity (Gs)	2,662
5	Soil classification according to USCS	OH
6	Soil classification according to AASHTO	A-7-6
7	Optimum moisture Content (W_{Opt})	28522%
8	Maximum dry density (γd)	1,419 gr/cm3
9	Cohesion (c)	25,7 kPa
10	Angle of Internal Friction (ϕ)	18,91°

3.2. RESULTS OF MIXED SOIL ASSESSMENT

1) The Effect of Mixed Soil on the Value of Moisture Content

The average moisture content of clay soil was 41.67%. Meanwhile, moisture content of mixed soil with the addition of 10% - 30% shell powder and 4% coal ash and stored for 24 hours afterward tended to decrease. A significant decrease in moisture content occurred at the addition of 25% shell powder, while the addition of 30% shell powder increased moisture content. Table 3, Figure 1.

Table 3

Table 3 Moisture Content	
Mixed Variations	**Soil Moisture Content (%)**
Clay Soil	27.43
Soil + 4% ash	27.09
Soil + 10% shell + 4% ash	26.43
Soil + 20% shell + 4% ash	25.64
Soil + 25% shell + 4% ash	26.15

Figure 1

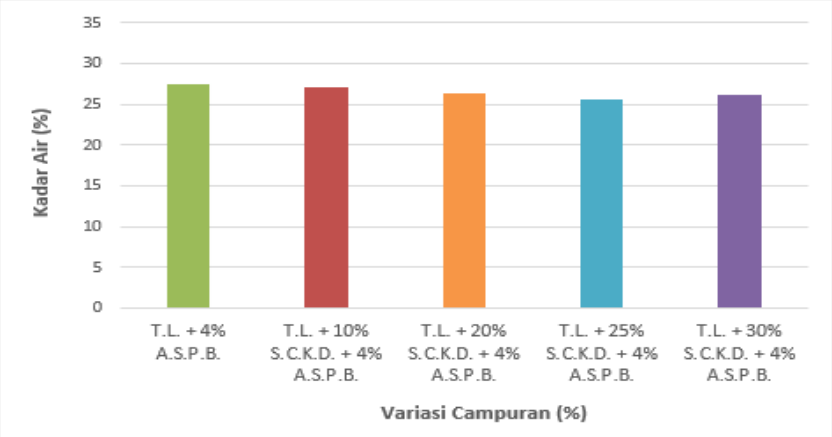

Figure 1 Graphic of Moisture Content

2) The Effect of Mixed Soil on the Liquid Limit Value

The addition of blood clam shell powder and 4% ash decreased liquid limit value. A significant decrease in the liquid limit value occurred with the addition of 20% blood clam shell powder. Meanwhile, at the addition of 25% and 30% blood clam shell powder, the liquid limit value constantly increased. Table 4, Figure 2

Table 4

Table 4 Liquid Limit Test

Mixed Variations	Liquid Limit Value (%)
Clay Soil	57.24
Soil + 4% ash	55.96
Soil + 10% shell + 4% ash	53.08
Soil + 20% shell + 4% ash	52.03
Soil + 25% shell + 4% ash	52.88
Soil + 30% shell + 4% ash	53.15

Figure 2

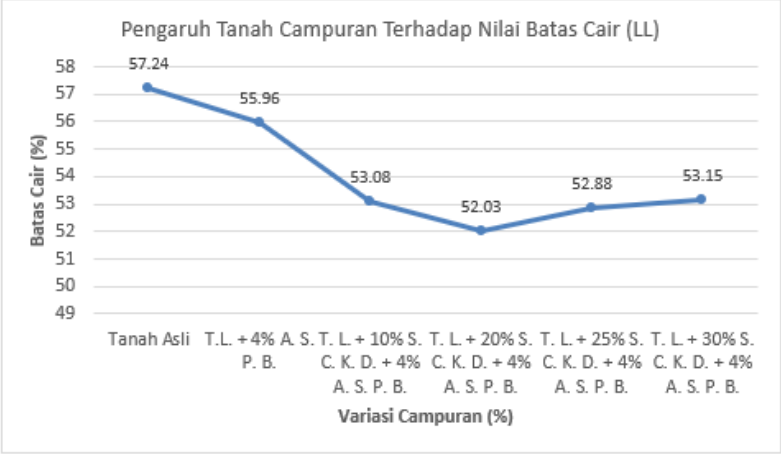

Figure 2 Graphic of Mixed Soil Liquid Limit

3) The Effect of Mixed Soil on the Plastic Limit Value

The addition of blood clam shell powder and 4% coal ash increased plastic limit value. The plastic limit value increased significantly at the addition of 20% shell powder. Table 5, Figure 3.

Table 5

Table 5 Mixed Soil Plastic Limit Test

Mixed Variations	Plastic Limit Value (%)
Clay Soil	28.63
Soil + 4% ash	29.73
Soil + 10% shell + 4% ash	31.33
Soil + 20% shell + 4% ash	32.92
Soil + 25% shell + 4% ash	30.80
Soil + 30% shell + 4% ash	29.68

Figure 3

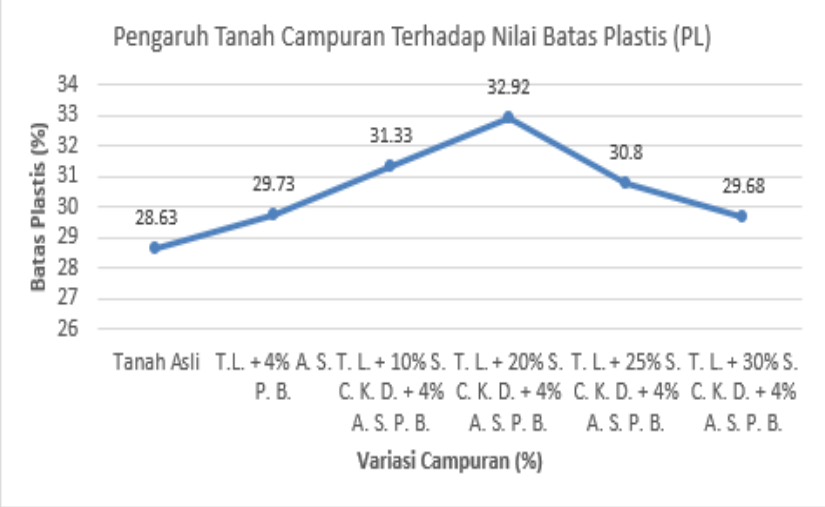

Figure 3 Graphic of Mixed Soil Plastic Limit Value

4) The Effect of Mixed Soil on the Plasticity Index (IP)

Table 6

Table 6 Mixed Soil Plasticity Index

Mixed Variations	Plastic Index (%)
Clay Soil	28.61
Soil + 4% ash	26.23
Soil + 10% shell + 4% ash	21.75
Soil + 20% shell + 4% ash	19.11
Soil + 25% shell + 4% ash	22.08
Soil + 30% shell + 4% ash	23.47

Figure 4

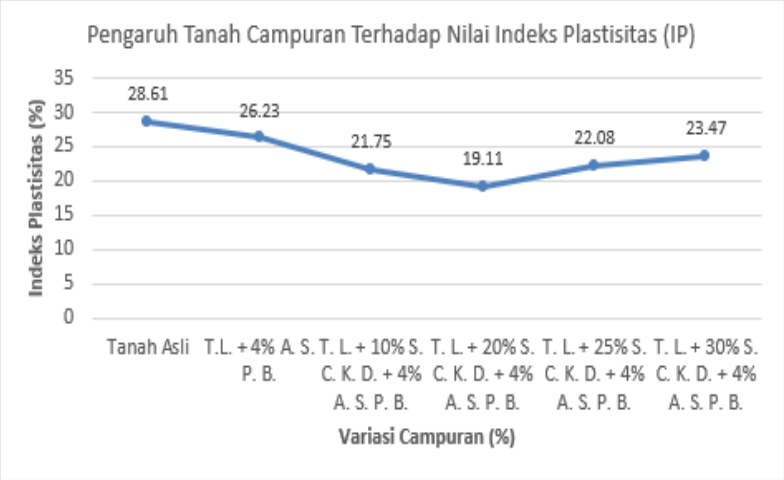

Figure 4 Graphic of Mixed Soil Plasticity Index

5) Effect of Mixed Soil on Specific Gravity

Table 7

Table 7 Mixed Soil Specific Gravity (Gs)

Mixed Variations	Plastic Limit Value (Gs)
Clay Soil	2.662
Soil + 4% ash	2.629
Soil + 10% shell + 4% ash	2.642
Soil + 20% shell + 4% ash	2.615
Soil + 25% shell + 4% ash	2.583
Soil + 30% shell + 4% ash	2.607

Figure 5

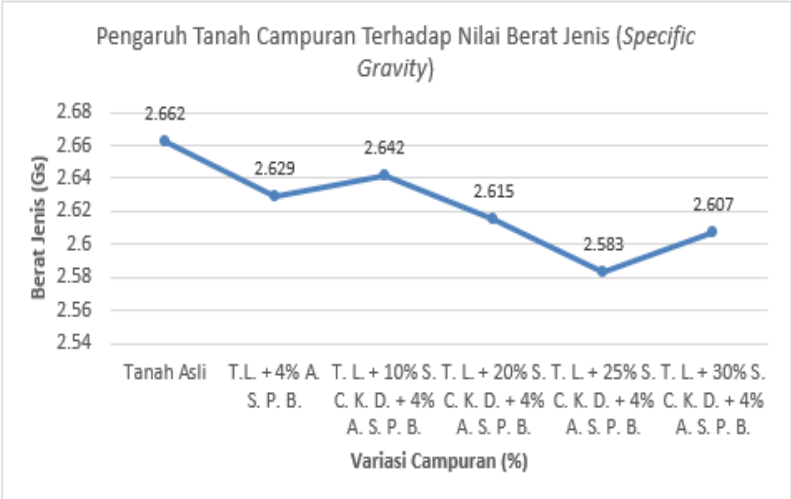

Figure 5 Graphic of Mixed Soil Specific Gravity

The addition of blood clam shell powder and 4% coal ash constantly decreased specific gravity values. The addition of 30% blood clam shell powder did not significantly increase the specific gravity.

6) Effect of Mixed Soil on Cohesion Value (*c*) and Angle of Internal Friction (ϕ)

Table 8

Table 8 Cohesion and Angle of Internal Friction of Mixed Soil

Mixed Variations	Cohesion, *c* (kPa)	Soil Shear Angleϕ (°)
Clay Soil	25.70	18.91
Soil + 4% ash	28.40	18.94
Soil + 10% shell + 4% ash	30.30	22.07
Soil + 20% shell + 4% ash	32.20	23.36
Soil + 25% shell + 4% ash	35.70	25.52
Soil + 30% shell + 4% ash	31.90	22.09

Figure 6

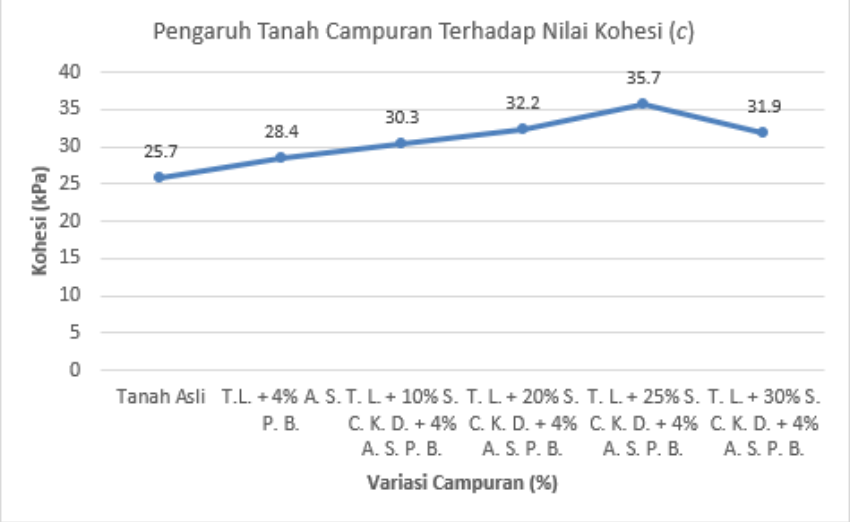

Figure 6 Graphic of Mixed Soil Cohesion Value

The addition of blood clam shell powder and 4% coal ash increased cohesion value. Increased value occurred relatively constant following the amount of blood clam shell powder and coal ash added. The highest cohesion value was obtained by the addition of 25% blood clam shell powder of 35.70 kPa. Meanwhile, the addition of 30% blood clam shell powder decreased cohesion value. Figure 7

Figure 7

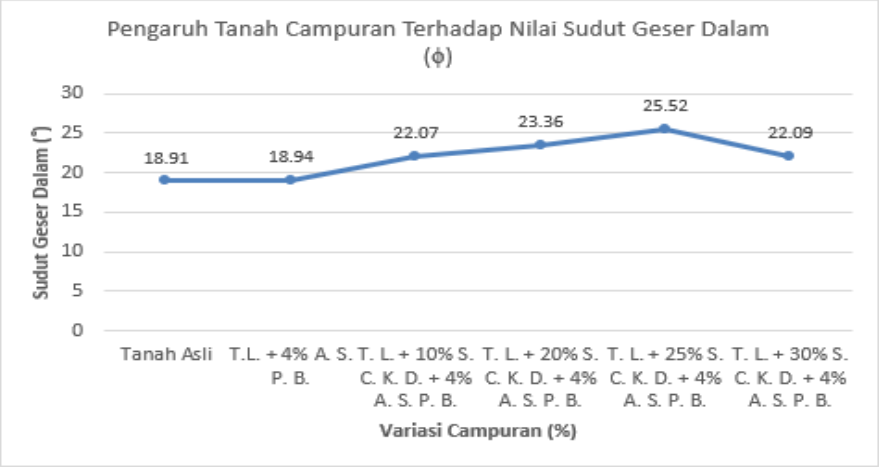

Figure 7 Graphic of Mixed Soil Angle of Internal Friction

The addition of blood clam shells significantly increased the angle of internal friction. It can be seen that the clay soil angle of internal friction value was 18.91°, while highest angle of internal friction of 25.52° was obtained by adding 25% blood clam shell powder.

- **Ground Shear Strength (τ)**

The shear strength of clay can be calculated using the Coulomb equation Hardiyatmo (1992).

Figure 8

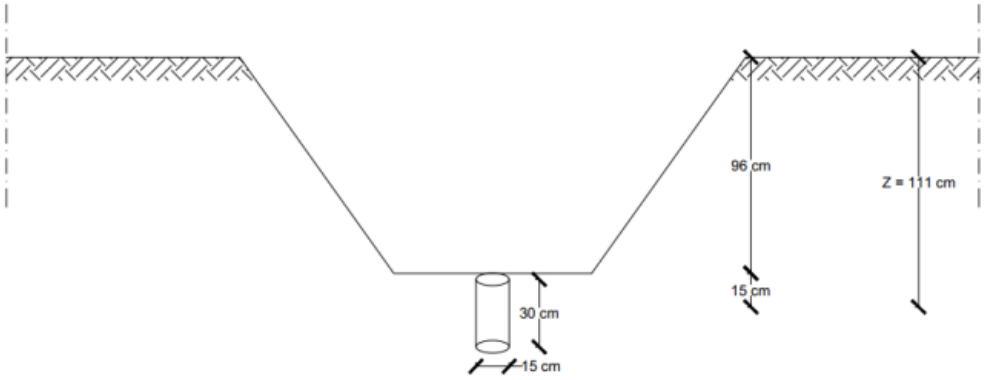

Figure 8 Sketch of Soil Sampling on Site

The clay sample at the sampling sites was taken at a depth of 1.1 meters from the soil surface, for the depth Z used in this shear strength calculation, the depth of soil extraction was added to half of the tube height. Table 9, Figure 9.

Table 9

Table 9 Recapitulation of Mixed Soil Shear Strength (τ)

Mixed Variation	Shear Strength, τ (kPa)
Clay Soil	25.716
Soil + 4% ash	28.422

Soil + 10% shell + 4% ash	30.323
Soil + 20% shell + 4% ash	32.224
Soil + 25% shell + 4% ash	35.724
Soil + 30% shell + 4% ash	31.923

Figure 9

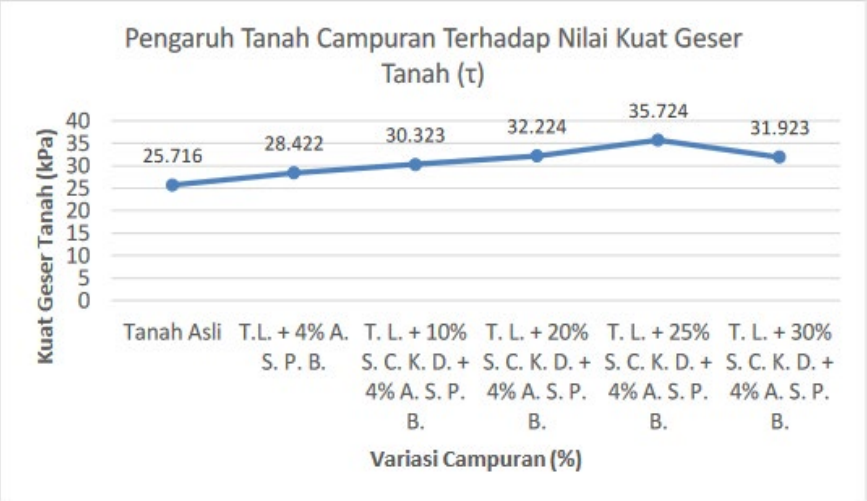

Figure 9 Graphic of Mixed Soil Shear Strength

4. CONCLUSION

1) Triaxial UU test obtained the cohesion value (c) of 25.716 kPa and the shear angle (ϕ) of 18.91º from clay soil without the addition of blood clam shell powder and coal ash. The addition of 25% blood clam shell powder increased the cohesion value and the shear angle to maximum points of 35.70 kPa and 25.52º, respectively.
2) The highest shear strength of 35,724 kPa was obtained by the addition of 25% blood clam shell powder.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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