Peertechz

Journal of Civil Engineering and Environmental Sciences
mail.civilengineering@peertechz.com
ENGINEERING GROUP

JOURNAL OF Civil Engineering and Environmental Sciences

ISSN: 2455-488X DOI: https://dx.doi.org/10.17352/jcees

Research Article

Analysis of relationship between strength compression and young modulus of red brick and white brick on application of strength and stiffness building construction with linear regression test

Jefrizal Sihombing, Rayhan Farisi R* and Risal Ardiansyah P

Department of Geophysical Engineering, Faculty of Civil, Environmental and Geo Engineering, Sepuluh Nopember Institute of Technology, Surabaya

Received: 06 December, 2019
Accepted: 14 September, 2020
Published: 18 September, 2020

***Corresponding author:** Rayhan Farisi R, Department of Geophysical Engineering, Faculty of Civil, Environmental and Geo Engineering, Sepuluh Nopember Institute of Technology, Surabaya,
E-mail: rayhanfr1@gmail.com

https://www.peertechz.com

Check for updates

Abstract

Building walls in Indonesia are often cracked due to natural and human factors. Therefore the building walls must have high strength and rigidity. The strength and rigidity of a material are interconnected. The higher the value of the strength of the material, the higher the stiffness value. And in Indonesia, in general, using white bricks and red bricks. This experiment aims to analyze and relate the compressive strength values with the modulus of young white bricks and red bricks with linear regression tests to determine suitable building materials for building wall construction. The compressive strength and modulus of young values are measured by means of a Vesta tester by recording weight dial and strain dial for each 10kN increase. Based on the elasticity and compressive strength test data, the compressive strength and modulus values of young bricks are obtained. The value of modulus young red brick, that is, the value of one sample red brick is (0-130) MPa. The value of the two red brick samples (0-20.62) MPa. The value of the red brick sample is three (0-3.82) MPa. While the modulus value of young white brick sample one is (0-44.86) MPa. The supply of two sample white bricks is (0-33.81) MPa. The value of the three sample white bricks is (0-77.97) N / m2. While the compressive strength value of white brick sample one is (0-3.27) MPa. The value of sample two white bricks is (0-3.44) MPa. The value of the three sample white bricks is (0.01-3.39) MPa. Whereas the compressive strength value of red brick sample one is (0-2.77) MPa. The value of red brick sample two is (0-2.14) MPa. The value of the three sample red bricks is (0-0.60) MPa. The tendency of compressive strength and modulus young values are directly proportional.

Introduction

These days, many construction walls of buildings are easily collapsed or damaged. This is caused by natural factors and human factors themselves. Natural factors are in the form of earthquakes, floods and other natural disasters, while human factors are caused wrongly in the selection of strong building materials as building wall construction. Therefore, the selection of raw materials for building wall construction is needed to reduce buildings that collapse due to natural or human factors. The selection of raw materials is based on the strength and stiffness values of these materials.

The strength and stiffness values in these bricks are different for each type of brick used. This is because there is a difference between one type of brick and another in the parameters of the young modulus and its compressive strength. This is very influential on the resilience of a building when subjected to a force when natural disasters occur and the resilience of a building within a certain period. In Indonesia,

Citation: Sihombing J, Rayhan Farisi R, Risal Ardiansyah P (2020) Analysis of relationship between strength compression and young modulus of red brick and white brick on application of strength and stiffness building construction with linear regression test. J Civil Eng Environ Sci 6(2): 016-021.
DOI: https://dx.doi.org/10.17352/2455-488X.000036

red brick and white brick is a material that is generally a need of the community for construction infrastructure facilities that are increasing with the times. For that reason, in this research we will conduct an experiment where we will analyze and relate the compressive strength values with the modulus of young white bricks and red bricks to determine suitable building materials for building wall constructions that have durability and stiffness values in accordance with the standard value of building walls.

Young modulus

Young's modulus is the ratio of normal tensile or compressive stress to strain. Young modulus depends on the age of the rock, aggregate properties and other compositions, loading speed, type and size of the test specimen.

According to Murdock and Brook [1], the actual modulus of elasticity or modulus at a certain time can be calculated by the following equation:

$$E_c = \frac{\sigma_2 - \sigma_1}{\varepsilon_2 - \varepsilon_1} \quad (1)$$

Where :

Ec = Modulus of elasticity

σ2 = Final stress

σ1 = First stress

ε1 = first strain

ε2 = first strain [2].

Compressive strength

Compressive strength or compression strength is the maximum magnitude of the broad unity load, which causes the concrete specimen to disintegrate when it is loaded with a certain compressive force produced by the press machine. Testing is done by giving a load / pressure until the test object collapses (Tjokrodimulyo, 1996). To find out the crushed stress of the test object is done by calculation:

$$\rho_c = \frac{P}{A} \quad (2)$$

Where :

ρ_c : Compressive Strength (MPa).

P : Maximum Load (N)

A : Cross-Sectional Area (mm^2) [3].

Regression test

Regression analysis is the study of the relationship problem of several variables displayed in mathematical equations. Linear regression is a statistical method used to model the relationship between the dependent variable (dependent; response; Y) with one or more independent variables (independent, predictor, X). Correlation that is not followed by regression is a correlation between two variables that do not have a causal relationship, or a functional relationship.

Equations that are often used when wanting to test a data with a regression method are:

a. *To find constants*

$$a = \frac{(\Sigma y)\ (\Sigma x^2)\ -(\Sigma x)\ (\Sigma xy)}{n(\Sigma x^2)\ -\ (\Sigma x)^2}$$

b. To find the regression coefficient

$$b = \frac{n(\Sigma xy)\ -\ (\Sigma x)\ (\Sigma y)}{n(\Sigma x^2)\ -\ (\Sigma x)^2} \quad \text{(Arikunto, 2013)}$$

Building wall

The wall is one of the building elements that functions to separate or form space. In terms of structure and construction there are two functions, namely as a structural wall and a fill or partition wall. Walls can be made of bricks, natural stone, wood and concrete in accordance with SNI [4-6].

Methodology

Tools and materials

In this experiment, there are several tools and materials that must be prepared to get the compressive strength and modulus data of young bricks. The tools and materials include: vesta tester which will be used to produce compressive forces against bricks, calipers to measure the diameter and height of bricks, then there is a coring tool that functions to produce bricks in the form of cylinders, and the last tool is the balance sheet electron to measure the mass of a brick. As for the material, there are red bricks and white bricks that have been cored.

Work steps

In this experiment, to measure the compressive strength and modulus of young bricks, both red and white bricks, first cast the bricks. After that, bricks are measured in diameter and height by using calipers. Then, measure the mass of the red brick and white brick using an electron balance. After that, the bricks are put into the Vesta tester to determine the compressive strength of the rock by paying attention to the weight dial and strain dial when the bricks are pressed with the tool. And record the value of the weight dial and strain dial every 10 kN increase to find the modulus young and compressive strength Figures 1-3.

Results and discussion

Data analysis

From the experiments that have been carried out, the following data are obtained Tables 1-6.

Citation: Sihombing J, Rayhan Farisi R, Risal Ardiansyah P (2020) Analysis of relationship between strength compression and young modulus of red brick and white brick on application of strength and stiffness building construction with linear regression test. J Civil Eng Environ Sci 6(2): 016-021.
DOI: https://dx.doi.org/10.17352/2455-488X.000036

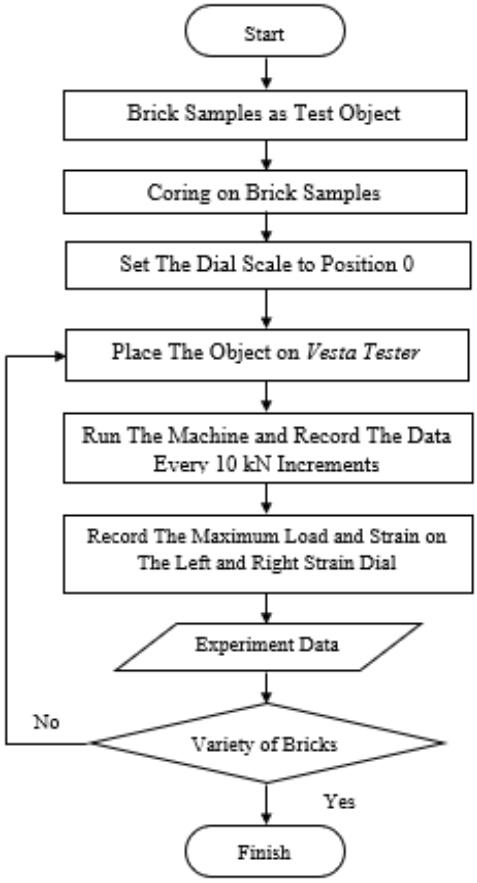
Calculation data

Young modulus analysis

Young Modulus value is used in calculating rock stiffness. The Young Modulus value for each rock is different, and can be found using the formula:

$$E_c = \frac{\sigma}{\varepsilon}$$

Based on elasticity experiments, the data obtained are Strains, P, D, r, Ho, and g. To calculate the young modulus the



Flowchart.

Figure 1: Strain Dial of *Versa Tester*. The function of the strain dial is to measure the strain that occurs on the brick sample when it is given a certain amount of load.

Figure 2: A sample of brick that began to crack when it is given a number of loads was calculated on how much strain occurs every 10 kN increments.

Figure 3: The *Versa Tester* shows the amount of load applied to the bricks which being tested.

Table 1: White Brick Experiment Data.

Sample	Ho	Strain	P	D	r	Ao	g
I	99.1	0	0	68.4	34.2	3672.7	10
		8.5	80				
		12.5	185				
		15.05	310				
		...	...				
II	101	0	0	66	33	3419.5	10
		4	75				
		6.85	150				
		12.5	275				
		...	...				
III	99.1	1.5	5	67.8	33.9	3608.5	10
		5	5				
		3.5	5				
		11	10				
		...	...				

Stress value is required, using the following formula:

$$\sigma = \frac{F}{A}$$

Citation: Sihombing J, Rayhan Farisi R, Risal Ardiansyah P (2020) Analysis of relationship between strength compression and young modulus of red brick and white brick on application of strength and stiffness building construction with linear regression test. J Civil Eng Environ Sci 6(2): 016-021.
DOI: https://dx.doi.org/10.17352/2455-488X.000036

Example :

Using data sample I sequence no 2 on white brick

$$A_o = 3.14 x r^2$$

$$A_o = 3.14 x (34.2)^2 = 3672.7$$

$$F = m x a$$

$$F = 293814$$

$$\sigma = \frac{293817}{3672.7} = 80$$

$$E_c = \frac{80}{8.5} = 9.411765 MPa$$

Table 2: Red Brick Experiment Data.

Sample	Ho	Strain	P	D	r	Ao	g
I	48	0	0	68	34	3608.5	10
		3.5	0				
		1.5	15				
		2.5	35				
		...	...				
II	48	0	0	68	34	3629.8	10
		4.5	40				
		6.5	65				
		9.5	100				
		...	...				
III	49	4	0	71.9	36	4024.4	10
		4	0				
		8.5	0				
		16.5	0				
		...	...				

Where :

P : Mass (kg)
D : Diameter (m)
R : Radius (m)
g : Gravitational Force (N)

Table 3: Young Modulus of White Brick Data.

Sample	Ho	Strain	P	D	r	Ao	g	F	Stress	Young Modulus
I	99.1	0	0	68.4	34.2	3672.7	10	0	0	0
		8.5	80					293814	80	9.411765
		12.5	185					679444	185	14.8
		15.05	310					1.00E+06	310	20.59801
		...	...					...	...	...
II	101	0	0	66	33	3419.5	10	0	0	0
		4	75					256460	75	18.75
		6.85	150					512919	150	21.89781
		12.5	275					940352	275	22
		...	...					...	...	...
III	99.1	1.5	5	67.8	33.9	3608.5	10	18043	5	0
		5	5					18043	5	1
		3.5	5					18043	5	1.428571
		11	10					36085	10	0.909091
		...	...					...	...	...

Table 4: Young Modulus of Red Brick Data.

Sample	Ho	Strain	P	D	r	Ao	g	F	Stress	Young Modulus
I	48.3	0	0	67.8	33.9	3608.5	10	0	0	0
		3.5	0					0	0	0
		1.5	15					54128	15	10
		2.5	35					1.26E+05	35	14
		...	...					...	...	...
II	48	0	0	68	34	3629.8	10	0	0	0
		4.5	40					145194	40	8.8888
		6.5	65					235940	65	10
		9.5	100					362984	100	10.52632
		...	...					...	...	...
III	49	4	0	71.6	35.8	4024.4	10	0	0	0
		4	0					0	0	0
		8.5	0					0	0	0
		16.5	0					0	0	0
		...	...					...	...	...

Table 5: Compressive Strength Data of White Bricks.

Sample	Ho	P	D	r	Ao	g	F	Compressive Strength
I	99.1	0	68.4	34.2	3672.7	10	0	0
		80					293814	0.2178
		185					679444	0.5037
		310					1.00E+06	0.8441
		...					...	...
II	101	0	66	33	3419.5	10	0	0
		75					256460	0.2193
		150					512919	0.4389
		275					940352	0.8042
		...					...	...
III	99.1	5	67.8	33.9	3608.5	10	18043	0.0139
		5					18043	0.0139
		5					18043	0.0139
		10					36085	0.0277
		...					...	...

Table 6: Compressive Strength Data of Red Bricks.

Sample	Ho	Strain	P	D	r	Ao	g	F	Stress	Young Modulus
I	48.3	0	0	67.8	33.9	3608.5	10	0	0	0
		3.5	0					0	0	0
		1.5	15					54128	15	0.0416
		2.5	35					1.26E+05	35	0.097
		...	...					...	...	...
II	48	0	0	68	34	3629.8	10	0	0	0
		4.5	40					145194	40	0.1102
		6.5	65					235940	65	0.1791
		9.5	100					362984	100	0.22755
		...	...					...	...	...
III	49	4	0	71.6	35.8	4024.4	10	0	0	0
		4	0					0	0	0
		8.5	0					0	0	0
		16.5	0					0	0	0
		...	...					...	...	...

Compressive strength analysis

The compressive strength value is obtained through standard testing procedures, using a testing machine by giving multilevel compressive load to the specimen until it is destroyed. And can be searched by the formula:

$$\rho_c = \frac{m x g}{A}$$

Citation: Sihombing J, Rayhan Farisi R, Risal Ardiansyah P (2020) Analysis of relationship between strength compression and young modulus of red brick and white brick on application of strength and stiffness building construction with linear regression test. J Civil Eng Environ Sci 6(2): 016-021.
DOI: https://dx.doi.org/10.17352/2455-488X.000036

Example :

Using data sample I sequence no 2 on white brick

$$\rho_c = \frac{80x10}{3673}$$

$$\rho_c = 0.21783\,MPa$$

Discussion

Based on elasticity and compressive strength test data, the compressive strength and modulus values of young white and red bricks are obtained. From the sample calculation, the value of modulus young red brick is obtained, that is, the value of red brick sample one is (0-130) MPa. The value of the two red brick samples (0-20.62) MPa. The value of the red brick sample is three (0-3.82) MPa. While the modulus value of young white brick sample one is (0-44.86) MPa. The supply of two sample white bricks is (0-33.81) MPa. The value of the three sample white bricks is (0-77.97) N / m2. Based on the elasticity test results obtained the greatest modulus young is sample one, and the smallest is sample three. If the greater the modulus young value, then the rock has better stiffness than other rocks. And rocks that have high modulus young values, means that rocks have high deformation, so rocks with high modulus young values are stronger against vibrations and other things that cause deformation. For young modulus standards based on SNI 03-2826-1992 that bricks are 2237 MPa, the following brick studies do not meet SNI standards.

Based on the following experiments, also obtained the compressive strength value of each sample. The compressive strength value of white brick sample one is (0-3.27) MPa. The value of sample two white bricks is (0-3.44) MPa. The value of the three sample white bricks is (0.01-3.39) MPa. Whereas the compressive strength value of red brick sample one is (0-2.77) MPa. The value of red brick sample two is (0-2.14) MPa. The value of the three sample red bricks is (0-0.60) MPa. Based on the compressive strength test results obtained by the largest compressive strength value is white brick sample two, and the smallest is red brick sample three. If the greater the compressive strength, the rock has better strength than other rocks. And rocks that have a high compressive strength value, means that these rocks have a stronger resistance and strength to withstand external and internal forces. For compressive strength standards based on SNI-S-04-1989-F that the bricks are 10 MPa, the following bricks research does not meet SNI bricks standards. Whereas the compressive strength standard for building walls based on SNI 03-2847 2002 is 20 MPa, so the brickwork study does not meet SNI standards.

Based on the data obtained by modulus young and compressive strength values, have a positive tendency based on linear regression test. Which means that the modulus of young and compressive strength are directly proportional. This means that if rocks have a high modulus young value, the compressive strength value will be high, and conversely the lower the modulus young value, the compressive strength value will be low too. In Figure 4 the red brick has the equation

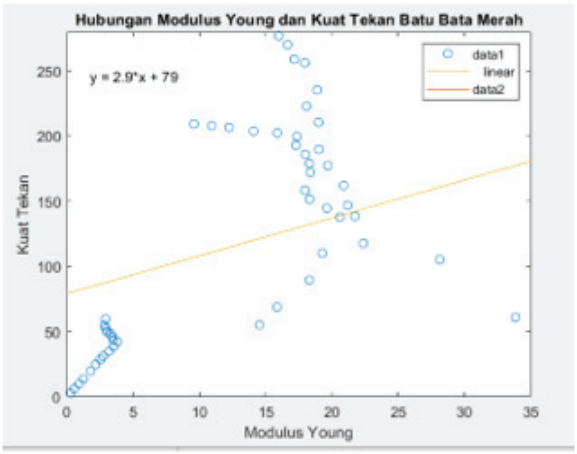


Figure 4: Relations between Young's Modulus and Compressive Strength of Red Bricks.

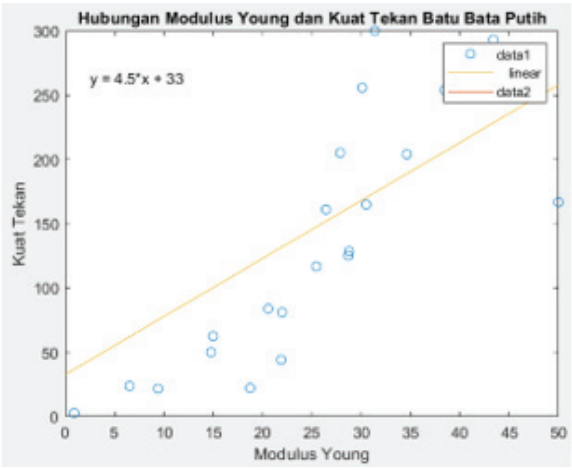


Figure 5: Relations between Young's Modulus and Compressive Strength of White Bricks.

y = 2.9x + 79, and has an r2 value of 15%. Based on the determinant coefficient values, it is proven that a lot of the distribution of compressive strength and modulus of young is not appropriate. Whereas in Figure 5 the white bricks have the equation y = 4.5x + 33, and have an r2 value of 49.76%. Based on the determinant coefficient values, it is proven that a lot of the distribution of compressive strength and modulus of young are not quite right either. This can be caused by a number of factors including errors when making bricks (mixing the exact curated aggregate, burning time that is less or more, etc.), errors when retrieving data (misreading strain dials or weight dials), and bricks surface uneven when cored. These things can cause the spread of compressive strength and modulus of young on white and red bricks spread unevenly.

Based on Figures 4,5 the determinant coefficient values both, show that the spread of white bricks is better than the spread of red bricks.In Indonesia, red brick and white brick is a material that generally becomes the construction of building walls. The value of strength and stiffness in bricks is very important so that the building does not collapse and is strong in the long run. Based on strength and elasticity test experiments, the compressive strength and young modulus values of the two

Citation: Sihombing J, Rayhan Farisi R, Risal Ardiansyah P (2020) Analysis of relationship between strength compression and young modulus of red brick and white brick on application of strength and stiffness building construction with linear regression test. J Civil Eng Environ Sci 6(2): 016-021.
DOI: https://dx.doi.org/10.17352/2455-488X.000036

types of bricks did not meet the SNI value. This is due to an error factor. However, the compressive strength and modulus of young white bricks are close to SNI standards compared to the compressive strength and modulus of young red brick. So white bricks are more suitable as construction materials of building walls than red bricks, because white bricks have high compressive strength values so that they have strength against the incoming force, and have a relatively high young modulus compared to red bricks so that they have elastic points that are higher and higher rigidity than red bricks.

Conclusion

Based on data obtained by modulus young and compressive strength values, has a positive tendency based on linear regression test. Which means that the modulus of young and compressive strength are directly proportional. This means that if rocks have a high modulus young value, the compressive strength value will be high, and conversely the lower the modulus young value, the compressive strength value will be low too, and white bricks are more suitable as construction material for building walls than red bricks, due to bricks white has a high compressive strength value so that it has strength to the incoming force, and has a relatively high modulus of young compared to red bricks so that it has a higher elastic point and higher rigidity than red bricks.

Supplementry data

References

1. Murdock LJ, Brook KM (1991) Bahan dan Praktek Beton (terjemahan Stephanus Hendarko). Jakarta: Penerbit Erlangga. Link: https://bit.ly/2HdjHUx
2. Gusanti W, Adi Sambowo K, Wibowo W (2014) Tinjauan Kuat Tekan Dan Modulus Elastisitas Beton Dengan Menggunakan Limbah Batu Candi Sebagai Pengganti Agregat Kasar. Matriks Teknik Sipil 2: 50-57. Link: https://bit.ly/3c8YqGO
3. Yunanto AD, Gunawan P, Sunarmasto S (2014) Studi Kuat Tekan, Kuat Tarik Belah, Dan Modulus Elastisitas Beton Ringan Teknologi Foam Dengan Bahan Tambah Serat Polyester. Matriks Teknik Sipil 2. Link: https://bit.ly/3kqWgoV
4. Tedja M, Charleshan C, Efendi J (2014) Perbandingan Metode Konstruksi Dinding Bata Merah dengan Dinding Bata Ringan. ComTech: Computer, Mathematics and Engineering Applications 5: 272-279. Link: https://bit.ly/2ZMBKaq
5. Frapanti S (2018) Studi Perhitungan Kekakuan Portal Dinding Bata Pada Bangunan Bertingkat Dari Beberapa Negara dengan Pushover. Educational Building Jurnal Pendidikan Teknik Bangunan dan Sipil 4: 1-10. Link: https://bit.ly/2ZLslA2
6. Suharsimi A (2006) Prosedur penelitian suatu pendekatan praktik. Jakarta: Rineka Cipta. Link: https://bit.ly/2FDzStxs

Citation: Sihombing J, Rayhan Farisi R, Risal Ardiansyah P (2020) Analysis of relationship between strength compression and young modulus of red brick and white brick on application of strength and stiffness building construction with linear regression test. J Civil Eng Environ Sci 6(2): 016-021.
DOI: https://dx.doi.org/10.17352/2455-488X.000036