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# Effect of Cement Composition in Lampung on Concrete Strength

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*Abstract* - **The strength and durability of concrete depends on the composition of its constituent materials ie fine aggregate, coarse aggregate, cement, water and other additives. The cement composition is about 10% acting as a binder paste material fine and coarse aggregates. In the Lampung market there are several brands of portland cement used by the community to make concrete construction. Although there is a standard of the government of portland cement composition, yet each brand of cement has different characteristics. Cement is generally composed of limestone / limestone containing calcium oxide (CaO), clay (clay) containing silica oxide (SiO2), aluminum oxide (Al2O3), iron oxide (Fe2O3) and a cast that serves to control the hardening. Cement manufacturers make products based on chemical elements resulting from the research to make their products better than other products, so although procedurally similar but have different composition and properties. Another difference are the density, start and end time of bonding and strength. This research will be conducted research on several brands of cement in the province of Lampung, among others, vicat test, the consistency test, compression test and bending in reinforced concrete beam structure. From the research it can be shown the cement test results as an input to the user as a result of the unequal nature of the cement.**

## I. Introduction

Concrete is a material that is formed by the hardening of a mixture of cement, water, fine aggregate and coarse aggregate and additive materials. Concrete is a construction material that has the durability ability, behavior and performance with good resistance to outdoor environments and has the compressive strength, but weak against tensile strength. This mixture of cement and water to form a cement paste that serves as connective material, while sand and crushed stone are fine and coarse aggregate material that serves as a filler and at the same material bound together by the cement paste.

As more and more brands of cement on the market, it is necessary to study the nature of each brand of cement that will be useful to the user community. Properties of cement will give effect to the quality of the concrete. In this study is limited to the effect of cement composition on cement brand different to the strength of reinforced concrete beams. There several cement brands circulating in Lampung analysis to be performed, namely Batu Raja, Padang, Holcim, Three Wheelers, Bosowa and Red and White. In addition to testing the composition and properties of cement for each brand, will be also a test of strength with the cement mix into the concrete and press test and load test on the beam structure of reinforced concrete. In the manufacture of concrete will be used fine aggregate or sand coming from the area of Gunung Sugih Lampung Selatan and coarse aggregate stone split from the Tanjungan Lampung Selatan. Compression testing will use cylindrical test specimens measuring 150 mm in diameter with a height of 300 mm were tested tap at the age of 14, 28 and 90 days, while the concrete beam specimen measuring 100 mm x 150 mm with a length of 1200 mm.


**Figure-1. Some brands of cement in the province of Lampung.**

The purpose and usefulness of research to determine the nature and characteristics of some brands of cement in Lampung and the extent to which the nature and characteristics of the cement affect the strength of reinforced concrete beams. Theoretically, this research is expected as contributions to the development of science in Civil Engineering and this research can increase knowledge for the writer and for the user community, especially cement.

**Methodology**

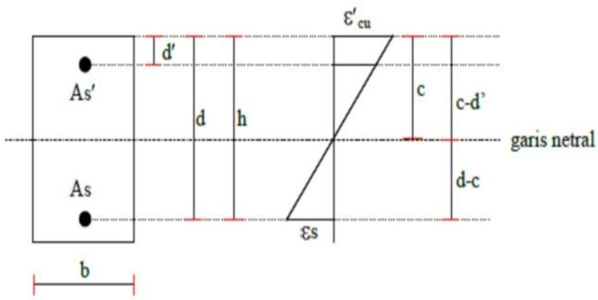
Portland cement is generally formed from the components of tricalcium silicate (C3S), dicalcium silicate (C2S), tricalcium aluminate (C3A) and tetra calcium ferrite alurnino (C4AF). Portland cement consists of four main oxidation namely lime CaO (60-66)%, silica SiO2 (19-25)%, alumina Al2O3 (3-8)% and Fe2O3 iron (1-5)%. When the grains of cement into contact with water, the surface layer of minerals in cement begins to react chemically with it. C2S undergo hydrolysis and hydration is accompanied by the formation of two new compounds: 3CaO.SiO2 + (n + 1) H2O 2CaO.Si.nH2O + Ca (OH) 2, while C2S and C3A only experienced hydrate formation as follows; 2CaO.SiO2 + nH2O = 2CaSiO2.nH2O (calcium hydroksilat). 3CaO.Al2O3 + 6H2O = 3CaO.Al2O3.6H20 (hydro calcium aluminate). The formation of hydrates compounds cause poorly soluble compounds, especially calcium compounds hydroksilat and quickly cause mortar (mortar). Hydrasi process of compound - calcium compounds occur only incentives at the time of the initial binding, penetration of water into the deeper layers of cement particles so that the interaction between water retained by the compound - complex compounds in the cement is reduced so that the process developed slowly. The next stage is the stage kolidal namely when Ca (OH) 2 became completely clear, the compound - a compound that decomposes Hydrat now soluble and stay in a state kolidal / gel. In the subsequent process of 3CaO.SiO2 hydrasi reaction occurs and produces CSH with a volume of more than twice the volume of cement, the CSM is to fill the cavity then forms a point of contact that results in stiffness. In the next stage a concentration of CSM who eventually becomes stiff and paste hardening process began to occur.

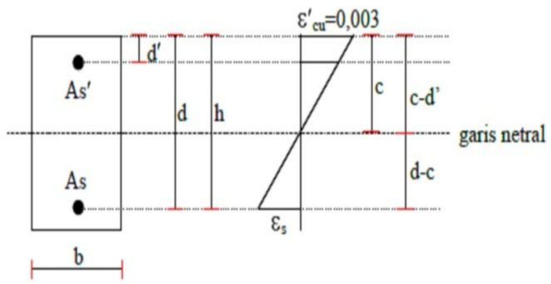
The character of the settings in the cement paste with water is referred to as a symptom of stiffness in the dough. There are two kinds of setting time (time binding) is the initial setting time (early binding time) is the time until the dough starts to happen start to happen a certain rigidity which is not workable dough has begun and the final setting time (late binding time) is the time is to begin to occur until the dough full rigor occurs. In general, setting time is affected by the content of C3A, C3A content greater will tend to produce short setting time and content of gypsum (CaSO4.2H2O), the greater the content of CaSO4.2H2O in the setting time of cement produces long.

**Figure-2. Vicat test equipment to determine the consistency and setting time**

Cement strength is measured compressive strength of the paste, mortar, concrete. In this study, tests conducted on cement strength is compression tests on the concrete, which is a mixture of cement, water, sand and rocks split at a certain ratio. Generally, the compressive strength is measured at 28 days, assuming the concrete has reached the strength of 100%. Test object to test the compressive strength of concrete cylinders with a diameter of 150 mm and a height of 300 mm while for flexural strength test specimen using a beam size of 100 mm x 150 mm with a length of 1200 mm. On the beam flexural strength testing is placed on two simple pedestal and given a concentrated load at midspan. By looking at the load and deflection of the beam to collapse it can be seen the beam flexural strength.

According to SNI 03-2847-2002 Article 12.2, in planning concrete structure components used assumptions are planning cross-section must meet the conditions of equilibrium of forces and strain compatibility, the strain in the reinforcement and concrete shall be assumed directly proportional to the distance from the neutral axis, except for high flexural structural components.






$$\frac{\varepsilon'_s}{\varepsilon'_{cu}} = \frac{c-d'}{c} \qquad \frac{\varepsilon_s}{\varepsilon'_{cu}} = \frac{d-c}{d}$$

**Figure-2. Vicat test equipment to determine the consistency and setting**

The maximum strain that can be used on the outermost fibers of concrete must be assumed to be equal to 0.003. In the bending test on a beam above two pedestal will be given by the two concentrated loads at mid-span in hopes of getting murnu bending loads on the beam.

Analysis of the cross-section is intended to calculate the flexural capacity nominal cross-sectional moment of reinforced concrete. The analysis was done by a square voltage pendekatanblok equivalent, with concrete compressive stress distribution and reganganbeton assumed rectangular.

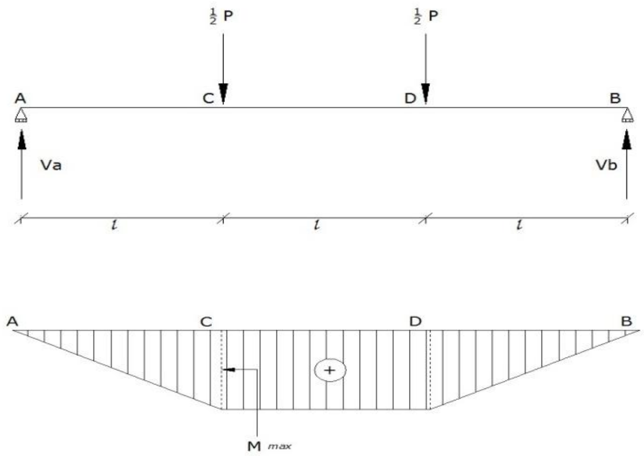



**Figure-4. Load on beam and the bending moment diagram on the test.**

$\sum M_a = 0$

$= (½ P.l) + (½ P.2l) – (Vb.3l)$

$Vb . 3l = (½ P.l) + (P.l)$

$Vb = \frac{1,5\, Pl}{3l}$

$= \frac{1}{2} P$

$\sum M_b = 0$

$= (Va.3l) – (½P.2l) – (½ P.l)$

$Va . 3l = (P.l) + (½ P.l)$

$Va = \frac{1,5\, Pl}{3l}$

$= \frac{1}{2} P$

Maximum moment, $M_{max} = P.l$

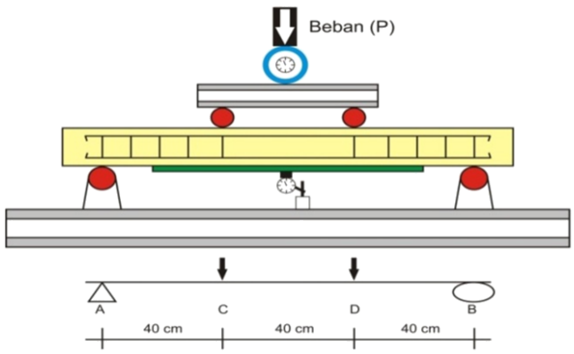



**Figure-5. Set-up testing on reinforced concrete beams in bending test.**

**Testing Results**

Giving the name of the test specimen on the test results do not use the brand name of
cement were tested but researchers will randomly named the specimen into the specimen A, B, C, D, E and F. This is intended to maintain competition among cement brand is not compromised.

| CEMENT | TIME (MINUTE) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 13 | 30 | 45 | 60 | 75 | 90 | 105 |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| A | 4.10 | 4.10 | 4.05 | 4.05 | 3.50 | 1.80 | 1.10 | 0.50 |
| B | 4.05 | 4.05 | 4.05 | 3.95 | 3.50 | 3.10 | 2.30 | 0.70 |
| C | 4.10 | 4.05 | 4.00 | 3.95 | 3.40 | 2.30 | 1.00 | 0.40 |
| D | 4.80 | 4.05 | 4.00 | 3.80 | 3.60 | 3.00 | 1.50 | 0.70 |
| E | 4.10 | 3.95 | 3.95 | 3.50 | 3.10 | 2.30 | 1.70 | 0.80 |
| F | 4.10 | 3.95 | 3.95 | 3.50 | 3.10 | 2.30 | 1.70 | 0.80 |

**Tabel-1. Result of vicat test.**

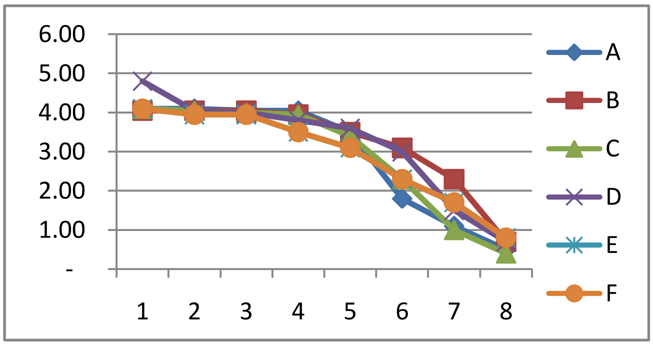



**Figure-6. Result of vicat test.**

| SEMEN | CONSISTENCY |
|---|---|
| | |
| A | 26.86% |
| B | 27.00% |
| C | 28.67% |
| D | 32.67% |
| E | 31.20% |
| F | 27.27% |

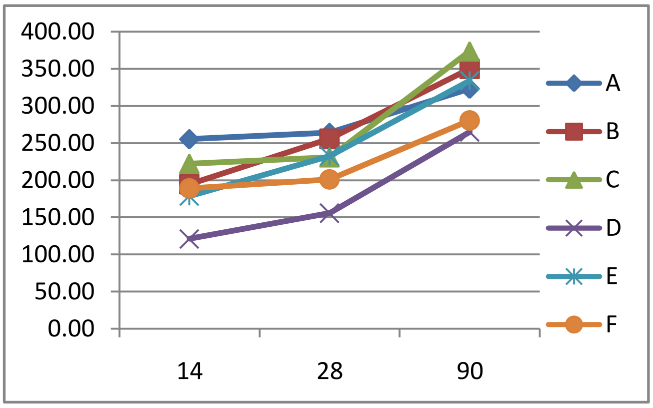
**Tabel-2. Result consistency test.**

| CEMENT | Element content | | |
|---|---|---|---|
| | Ca | Fe | Al |
| | %(b/b) | %(b/b) | %(b/b) |
| A | 27.67 | 1.32 | 1.66 |
| B | 48.80 | 2.04 | 2.70 |
| C | 30.53 | 2.07 | 2.70 |
| D | 43.48 | 2.19 | 2.61 |
| E | 46.12 | 2.00 | 2.66 |
| F | 36.23 | 1.81 | 2.58 |

**Tabel-3. Result of elemen content test.**

| CEMENT | AGE (DAY) | DENSITY | | AGE (DAY) |
|---|---|---|---|---|
| | 14 | 28 | CEMENT | 14 |
| | | | | |
| A | 255.47 | 264.02 | A | 255.47 |
| B | 194.84 | 255.95 | B | 194.84 |
| C | 222.27 | 230.93 | C | 222.27 |
| D | 121.23 | 155.86 | D | 121.23 |
| E | 178.97 | 232.85 | E | 178.97 |
| F | 189.18 | 201.10 | F | 189.18 |

**Tabel-4. Result of compression test and density.**




**Gambar-7. Result of compression test.**

| SEMEN | P max (kg) |
|---|---|
| | |
| A | 2380 |
| B | 2330 |
| C | 2330 |
| D | 2645 |
| E | 2710 |
| F | 2535 |

**Tabel-5. Flexural test of reinforce concrete beam.**

**Discussion**

From the test results can be seen in the composition of each cement and concrete strength where the cement into the bonding material.
In the vicat test, the results are not much of a difference for all cement. There is only one piece of cement ie cement D that has the highest price at the time of initial or t = 0, ie 4.8. And at t = 105 cement C has the lowest price, which is 0.50. Lowest for the consistency of cement A is 26.86% and the highest consistency in cement D 32.67%.
In the test content of chemical elements contained in the semen are the most visible cement containing cement B element Ca is at 48.80% (b/b) and the smallest is a cement 27.67% (b/b). Highest Fe element present in cement D is equal to 2:19% (b/b) and the smallest one is on a cement of 1:32% (b/b). And content of elements contained in the Al largest cement B and C is equal to 2.7% (b/b) and the content of Al smallest element is on a cement that is equal to 1.66% (b/b).
Compressive strength test results showed the following results, which is the largest press test at the age of 14 days there on the cement A of 255.47 kg / cm2 and pressure tests on cement D smallest of 121.23 kg / cm2. At the age of concrete achievement of the 90-day compressive strength achieved by the largest cement C of 373.66 kg / cm2 and the smallest compression test is 265.02 kg / cm2 in cement D.
Flexure testing on reinforced concrete beams will get an average maximum force that caused the collapse in the beam, amounting to 5 piece for each cement. From the test results obtained maximum compression force was 2710 kg in most reinforced concrete beams using cement E. While the use of cement blocks B and C reach collapse when receiving a load of 2330 kg.

**Conclusion**

From the results of several tests can be concluded, among other things that the chemical composition of each brand of cement that is in Lampung is different. These differences lead to differences in the nature and powers of concrete using cement as a binder. There is a brand of cement that can produce a large force at the beginning (age 14 days), but there are also some concrete will get maximum strength after a long time (age 90 days).

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