The effect of curing in soil and compound on compressive strength of concrete quality f'c 25 MPa

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Abstract. Concrete is a material that dominates high-rise building construction materials, because concrete materials are easy to obtain and able to withstand very large loads. In addition, concrete can be made in various forms so that according to needs and can beautify the shape of a building, easy to maintain, durable and relatively cheap prices. But in the implementation of using concrete, there are times when found concrete needs to be perforated on its appearance for the purposes of supporting facilities for building functions such as sanitation, gas, hydrants and others. To increase the compressive strength of concrete so that it meets the desired requirements in addition to the quality of the material, the casting process is also required after the casting. This treatment can be done by several methods, among others: immersion in water, wrapped in wet burlap sacks, watering with water, spraying by compounding, and can also be done by landfilling. Through treatment is expected to be obtained the quality of concrete as planned. Because with the maintenance of concrete, the security of the building structures made of concrete will be assured security. Beside that, concrete is required for minimum usage of 50 years. Therefore the research was carried out with the title "Effect of Soaking (Curing) in Soil and Compound on Compressive Strength of Concrete Quality Fc' 25" MPa by using 40 cylindrical concrete specimens and each treatment consisted of 8 test specimens with 300 high dimensions mm and a diameter of 150 mm. Results of a strong test of concrete press performed after the concrete aged 14 days and subsequently converted to a 28-day old concrete produce : Strong high average press that is on concrete with the treatment of using water immersion with a strong press of 23.78 MPa, while the lowest average press is in concrete with the treatment of using a strong burlap sack with a tekasn of 21.88 MPa. Concrete elastic modulus testing using 4 specimens produces an average modulus of elasticity of 24919.59 Mpa.

1. Introduction
Concrete is a material that dominates high-rise building construction materials, because concrete materials are easy to obtain and able to withstand very large loads. In addition concrete can be made various forms so as to suit the needs and can beautify the shape of a building, easy to maintain, durable and relatively inexpensive price. But in the implementation by using concrete, there are times when concrete is found to be in a hole in the container for the purpose of supporting the building functions such as sanitation, gas, hydrants and others.

Based on the research conducted, the average compressive strength and average tensile strength for concrete with normal maintenance are 21,989 MPa and 2,951 MPa. Average compressive strength and
average tensile strength of concrete with treatment in the mud is 19,361 MPa and 2,698 MPa or there is a decrease of 0.119% and 0.0856% of normal concrete compressive strength. Average compressive strength and average tensile strength of concrete with treatment in seawater are 18,021 MPa and 2,506 MPa or there is a decrease in 0.180% and 0.151% of the compressive strength and tensile strength of normal concrete [3].

At the age of 7 days, the maximum compressive strength value of PDAM water, sea water and sewage water are 13.522 MPa, 8.759 MPa, 10.296 MPa, respectively. The compressive strength value of PDAM water at the age of 7 days has increased compared to the compressive strength value of sea water and sewage water, while the compressive strength value of sea water has decreased compared to that of sewage water which has increased. So it can be concluded that the highest compressive strength value is PDAM water at the age of 7 days [5].

From the research that has been done to find out how much it affects the curing has on the strength of concrete. Obtained the result that the compressive strength of concrete with the treated (curing) by soaked turns to have a higher strength and end than on left in the open air/without curing. Where the strength of curing concrete turns beyond the compressive strength of the initial plan’s compressive strength. As for the uncuring concrete is apparently the force of the press obtained less than the planned compressive strength [11].

According to [3] at the time of execution of regular casting, the lack of perfect compaction, the pouring of its density and imperfect compaction so that the concrete mixture will be not homogeneous. To increase the compressive strength of the concrete firmly so as to meet the desired condition in addition to the quality of material, the implementation of casting is required also after-casting treatment. This treatment can be done by several methods, among others: immersion in water, wrapped in a wet burlap sack, watering with water, spraying by compounding, and also can be done with a filling in the soil.

A curing is a process to keep the humidity and temperature levels ideal to prevent excessive hydration and keep the hydration going on continuously. Curing is generally understood as a concrete treatment, which aims to keep concrete not too fast to lose water, or as an act of maintaining moisture and temperature of concrete, as soon as the concrete finishing process is finished and the total time setting is reached.

Through treatment is expected to be obtained the quality of concrete as planned. Because with the treatment of concrete, the safety of the building structures made of concrete will be assured security. Beside that, concrete is required for minimum usage of 50 years.

2. Research method
The research was conducted using quantitative research methods with an experimental approach based on SNI 2847-2002 and ACI 440-2R-02 in testing. The initial stage in this study was to calculate the compressive strength that occurred on normal concrete cylinders at the age of 14 days. Furthermore, testing for concrete with several treatment methods, namely: treatment immersed in water, treatment in a pile in the soil, and treatment with a compound that is also after the age of 14 days.

Concrete cylinder specimens with diameter size 15 cm height 30 cm where 44 test objects and each treatment was 8 specimens for a compressive strength test and 4 specimens for modulus of elasticity with 25 MPa concrete quality plan. Concrete used is a concrete with the quality of FC’ 25 MPa obtained from the purchase at Varia Usaha Beton Malang ready mix.

Analysis of the data on this research using quantitative descriptive is to take the test result data and describe it in chart form with the test "One Way Anova Analysis". Statistical analysis results in the form of a concrete compressive strength test of the difference in treatment.

3. Result and discussion

3.1 Concrete compressive strength
Test result of compressive strength test of cylindrical concrete using UTM (Universal Testing Machine) conducted at Civil Engineering Laboratory Building D9 State University of Malang, are using cylindrical concrete with the dimensions of the specimens has a diameter of 150 mm, height 300 mm that is tested when the concrete is 14 days old and with a difference in the way of treatment. The result of the 14-day concrete compressive strength that occurred next converted to concrete age 28 days using the Indonesian Concrete Regulation. namely by dividing the compressive strength that occurs with the value of 0.88 can be seen as in the table 1 up to the table 6 as follows

**Table 1.** Results compressive strength test of cylindrical concrete with normal treatment (BN).

| No | Weight of Specimens (kg) | UTM Load Reading P (kN) | Tools Calibration P (kN) | Loads P (kN) | Loads P (N) | Cross-sectional Area A (mm²) | Compressive Strength f’c (MPa) | Compressive Strength Conversion f’c’ (MPa) |
|----|--------------------------|------------------------|-------------------------|-------------|------------|-----------------------------|-------------------------------|-------------------------------|
| BN1| 11.9                     | 346.2                  | 12.8                    | 333.4       | 333400     | 17662.5                     | 18.88                         | 21.47                         |
| BN2| 12                       | 348.8                  | 12.8                    | 336         | 336000     | 17662.5                     | 19.02                         | 21.64                         |
| BN3| 11.5                     | 359.7                  | 12.8                    | 346.9       | 346900     | 17662.5                     | 19.64                         | 22.34                         |
| BN4| 12.3                     | 355.8                  | 12.8                    | 343         | 343000     | 17662.5                     | 19.42                         | 22.09                         |
| BN5| 11.8                     | 380.6                  | 12.8                    | 367.8       | 367800     | 17662.5                     | 20.82                         | 23.69                         |
| BN6| 12                       | 404.4                  | 12.8                    | 391.6       | 391600     | 17662.5                     | 22.17                         | 25.22                         |
| BN7| 11.7                     | 366.3                  | 12.8                    | 353.5       | 353500     | 17662.5                     | 20.01                         | 22.77                         |
| BN8| 11.7                     | 387.8                  | 12.8                    | 375         | 375000     | 17662.5                     | 21.23                         | 24.15                         |

**AVERAGE COMPRESSIONAL STRENGTH**

22.92

**Table 2.** Results compressive strength test of cylindrical concrete with immersed in soil (BT).

| No | Weight of Specimens (kg) | UTM Load Reading P (kN) | Tools Calibration P (kN) | Loads P (kN) | Loads P (N) | Cross-sectional Area A (mm²) | Compressive Strength f’c (MPa) | Compressive Strength Conversion f’c’ (MPa) |
|----|--------------------------|------------------------|-------------------------|-------------|------------|-----------------------------|-------------------------------|-------------------------------|
| BT1| 11.9                     | 364.6                  | 12.8                    | 351.8       | 351800     | 17662.5                     | 19.92                         | 22.66                         |
| BT2| 12.2                     | 376.3                  | 12.8                    | 363.5       | 363500     | 17662.5                     | 20.58                         | 23.41                         |
| BT3| 12.2                     | 346.0                  | 12.8                    | 333.2       | 333200     | 17662.5                     | 18.86                         | 21.46                         |
| BT4| 12.1                     | 399.1                  | 12.8                    | 386.3       | 386300     | 17662.5                     | 21.87                         | 24.88                         |
| BT5| 12.3                     | 387.9                  | 12.8                    | 375.1       | 375100     | 17662.5                     | 21.24                         | 24.16                         |
| BT6| 12.3                     | 401.2                  | 12.8                    | 388.4       | 388400     | 17662.5                     | 21.99                         | 25.02                         |
| BT7| 12.2                     | 326.2                  | 12.8                    | 313.4       | 313400     | 17662.5                     | 17.74                         | 20.19                         |
| BT8| 12.3                     | 405.6                  | 12.8                    | 392.8       | 392800     | 17662.5                     | 22.24                         | 25.30                         |

**AVERAGE COMPRESSIONAL STRENGTH**

23.39

**Table 3.** Results compressive strength test of cylindrical concrete with compounding (BC).
| No | Weight of Specimens (kg) | UTM Load Reading P (kN) | Tools Calibration P (kN) | Loads P (kN) | Loads P (N) | Cross-sectional Area A (mm²) | Compressive Strength fc' (MPa) | Compressive Strength Conversion fc' (MPa) |
|----|-------------------------|-------------------------|-------------------------|--------------|-------------|-----------------------------|-----------------------------|-------------------------------|
| BC1 | 12                      | 395.6                   | 12.8                    | 382.8        | 382800      | 17662.5                     | 21.67                       | 24.66                         |
| BC2 | 11.9                    | 368.2                   | 12.8                    | 355.4        | 355400      | 17662.5                     | 20.12                       | 22.89                         |
| BC3 | 11.9                    | 342.8                   | 12.8                    | 330.000      | 17662.5     | 18.68                       | 21.26                       |                               |
| BC4 | 12.1                    | 381                    | 12.8                    | 368.2        | 368200      | 17662.5                     | 20.85                       | 23.72                         |
| BC5 | 12                      | 329.9                   | 12.8                    | 317.1        | 317100      | 17662.5                     | 17.95                       | 20.42                         |
| BC6 | 11.9                    | 348.5                   | 12.8                    | 335.7        | 335700      | 17662.5                     | 19.01                       | 21.62                         |

| No | Weight of Specimens (kg) | UTM Load Reading P (kN) | Tools Calibration P (kN) | Loads P (kN) | Loads P (N) | Cross-sectional Area A (mm²) | Compressive Strength fc' (MPa) | Compressive Strength Conversion fc' (MPa) |
|----|-------------------------|-------------------------|-------------------------|--------------|-------------|-----------------------------|-----------------------------|-------------------------------|
| BC7 | 11.6                    | 362.2                   | 12.8                    | 349.4        | 349400      | 17662.5                     | 19.78                       | 22.51                         |
| BC8 | 11.9                    | 396.5                   | 12.8                    | 383.7        | 383700      | 17662.5                     | 21.72                       | 24.71                         |

**AVERAGE COMpressive Strength** 22.72

**Table 4. Results compressive strength test with jute sack covered (BG).**

| No | Weight of Specimens (kg) | UTM Load Reading P (kN) | Tools Calibration P (kN) | Loads P (kN) | Loads P (N) | Cross-sectional Area A (mm²) | Compressive Strength fc' (MPa) | Compressive Strength Conversion fc' (MPa) |
|----|-------------------------|-------------------------|-------------------------|--------------|-------------|-----------------------------|-----------------------------|-------------------------------|
| BG1 | 12.1                    | 362.7                   | 12.8                    | 349.9        | 349900      | 17662.5                     | 19.81                       | 22.54                         |
| BG2 | 11.9                    | 388.3                   | 12.8                    | 375.5        | 375500      | 17662.5                     | 21.26                       | 24.19                         |
| BG3 | 11.9                    | 358.3                   | 12.8                    | 345.5        | 345500      | 17662.5                     | 19.56                       | 22.25                         |
| BG4 | 12.1                    | 383                    | 12.8                    | 370.2        | 370200      | 17662.5                     | 20.96                       | 23.84                         |
| BG5 | 12.3                    | 316.7                   | 12.8                    | 303.9        | 303900      | 17662.5                     | 17.21                       | 19.57                         |
| BG6 | 12.2                    | 327.1                   | 12.8                    | 314.3        | 314300      | 17662.5                     | 17.79                       | 20.24                         |
| BG7 | 12.1                    | 330.4                   | 12.8                    | 317.6        | 317600      | 17662.5                     | 17.98                       | 20.46                         |
| BG8 | 11.8                    | 353.5                   | 12.8                    | 340.7        | 340700      | 17662.5                     | 19.29                       | 21.94                         |

**AVERAGE COMpressive Strength** 19.23 21.88

**Table 5. Results compressive strength test with soaking in water (BA).**
### Table 6. Average cylinder concrete compression strength test results with each treatment.

| No | Cylinder Concrete Test Objects Treatment | Average Compressive Strength (MPa) |
|----|-----------------------------------------|-----------------------------------|
| 1  | BN                                      | 22.92                             |
| 2  | BT                                      | 23.39                             |
| 3  | BC                                      | 22.72                             |
| 4  | BG                                      | 21.88                             |
| 5  | BA                                      | 23.78                             |

Notes:
BN = Compressive Strength Test of Cylindrical Concrete with Normal Treatment
BT = Compressive Strength Test of Cylindrical Concrete with Immersed in Soil
BC = Compressive Strength Test of Cylindrical Concrete with Compounding
BG = Compressive Strength Test with Jute Sack Covered
BA = Compressive Strength Test with Soaking in Water

From the results of the compressive strength of the average cylinder concrete with each treatment obtained graphs as in Figure 3.1 as follows

**Figure 1.** Graph of compressive strength of average concrete with each treatment.

From the result of average compressive strength of cylindrical concrete with each treatment can be concluded the concrete using the treatment soaked in water has the highest average compressive strength of 23.78 MPa, next is a concrete with the treatment using the burlap sacks has a compressive strength the lowest average is 21.88 MPa.

### 3.2 Statistical analysis of concrete compressive strength

Hypothesis testing is conducted to determine whether there is a compressive strength difference that occurs in concrete cylinders that have a difference for treatment. The testing of the hypothesis was conducted using the one-way ANOVA analysis using the SPSS V.18 application with the hypothesis formulation in the study is:

- **H1**: There are differences in the compressive strength of concrete with different treatments
- **H0**: There is no difference in the compressive strength of concrete with different treatments

Based on the results of the one-way ANOVA testing performed on the compressive strength of concrete cylinder with the difference in the way the treatment obtained result is $F = 1.896$, $df_3 = 4$, $df_4 = 35$, then $F_{table}$ is 2.64 and the significance level is 0.133. From the calculate $F$ value of $1.896 < 2.64 F_{table}$, it can be concluded that $H_0$ is accepted and $H_1$ is rejected. While the significance value is 0.133 > 0.05, then $H_0$ is accepted and it can be state there is no significant difference regarding compressive strength concrete with different treatment.
Post hoc test is done to know the compressive strength of concrete cylinders with different treatments. Because the significance value 0.133 > 0.05 then it can be deduced H0 received or no significant difference in the compressive of concrete with different treatments.

3.3 Concrete elasticity module

The results of the modulus of elasticity testing of cylindrical concrete using UTM (Universal Testing Machine) conducted at the Civil Engineering Laboratory Building State University of Malang, namely by using concrete cylinder with the dimensions of the specimens has a diameter of 150 mm with a height of 300 mm with a total of 4 test objects tested when the cylinder concrete is 14 days old.

Concrete elastic modulus testing was carried out in accordance with ASTM C469. The calculation of modulus of elasticity is obtained by 45% of the maximum load that is subsequently acquired strain and Voltage 1 and subsequently necari strain with a value of 0.00005 according to the regulations and produce voltage and strain 2. Furthermore, the modulus of elasticity is obtained by the stress formula divided by strain. In table 8.1 shows the modulus of elasticity on average after the calculation is 24919.59 MPa. The results of the cylindrical concrete modulus elasticity test can be seen as in table 7 as follows.

In Figure 2 is obtained comparison between stress and strain on concrete after testing of modulus of elasticity. In the concrete cylinder the first test specimen obtained the smallest stress and strain and the fourth specimen obtained the largest stress and strain. The graph of the stress and strain on the modulus elasticity testing of cylindrical concrete can be seen in Figure 2.

| No | Modulus elasticity (MPa) | Average of modulus elasticity (MPa) |
|----|-------------------------|------------------------------------|
| 1  | 31293.25                |                                    |
| 2  | 29360.06                |                                    |
| 3  | 10209.91                |                                    |
| 4  | 28815.16                | 24919.59                           |

Figure 2. Graph of concrete stress dan strain.

4. Conclusion

Based on the results and discussion in a study entitled "The Effect of Soaking (Curing) in Soil and Compound on Concrete Compressive Strength of Fc 25 MPa" it can be concluded as follows:
1) The results of the concrete compressive strength test carried out after the concrete was 14 days old and subsequently converted to 28-day-old concrete yielded the highest average compressive strength,
namely the concrete treated using water immersion with compressive strength of 23.78 MPa, while the average compressive strength the lowest mean is in concrete with maintenance using burlap sacks with a strong pressure of 21.88 MPa.

2) Based on the data analysis test using "One Way Anova Analysis" using SPSS V.18 application which is performed on compressive strength of cylindrical concrete with different treatment methods, the results are F = 1.896, df3 = 4, df4 = 35, then Ftable is 2, 64 and the significance level of 0.133. From the calculated F value of 1.896 <2.64 Ftable, it can be concluded that H0 is accepted and H1 is rejected. While the significance value of 0.133 > 0.05, Ho is accepted and it can be stated that there is no significant difference regarding the compressive strength of concrete with different treatments. From the post hoc test results, the significance value of 0.133 > 0.05, it can be concluded that H0 is accepted or there is no significant difference in the compressive strength of concrete with different treatments.

3) Concrete elastic modulus testing using 4 specimens resulted in an average modulus of elasticity of 24919.59 MPa.

References

[1] Angjaya and Novi et al 2013 Perbandingan Kuat Tekan Antara Beton dengan Perawatan Pada Elevated Temperature dan Perawatan dengan Cara Perendaman Serta Tampak Perawatan (Manado: Teknik Sipil Universitas Samratulangi)

[2] Direktorat Riset dan Pengabdian Masyarakat 2018 Panduan Penelitian dan Pengabdian Kepada Masyarakat XII ed.

[3] Fauzi and Anwar D 2013 Analisis Kuat Tekan dan Kuat Tarik Beton dengan Perawatan dalam Lumpur dan Air Laut (Surakarta: Universitas Muhammadiyah)

[4] Oscar N F 2009 Kajian Ekspamanal Perilaku Balok Beton Bertulang Tunggal Berdasarkan Tipe Keruntuhan Balok J. Civil Eng. 5 (2): 44

[5] Saputra and Dwi R et al 2017 Pengaruh Air PDAM, Laut, Comberan Pada Proses Curing terhadap Kuat Tekan Beton fc’ 14,53 MPa (Lamongan: Teknik Sipil Universitas Islam)

[6] Kuhn T 1998 Density matrix theory of coherent ultrafast dynamics Theory of Transport Properties of Semiconductor Nanostructures (Electronic Materials vol 4) ed E Schöll (London: Chapman and Hall) chapter 6 pp 173–214

[7] SNI (Standart Nasional Indonesia) 03-2847-2002 2002 Persyaratan Beton Struktural Untuk Bangunan Gedung (Indonesia: BSN)

[8] SNI (Standart Nasional Indonesia) 03-2847-2013 2013 Persyaratan Beton Struktural Untuk Bangunan Gedung (Indonesia: BSN)

[9] Simanjuntak and Johan O et al 2015 Hubungan Peralatan Beton dengan Kuat Tekan (Medan: Universitas HKBP Nommensen)

[10] Supriyadi, Eko A, Nadia 2013 Studi Analisis Lentur Pada Balok Tumpuan Yang Mengalami Pengeroposan Beton J. Cons. 4

[11] Sutandar and Erwin 2013 Pengaruh Pemeliharaan (Curing) pada Kuat Tekan Beton Normal (Pontianak: Universitas Tanjungpura)