Evaluation of compressive strength investigation on job mix test object and core drill test object

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Abstract. The test sample in the core drill is a hard concrete test (ASTM C-39) method by taking samples of concrete cylinders from areas of compressive strength is doubtful. Sampling is done by drill tool which drill is in the form of "pipe" from diamond, so that the concrete sample is obtained in the form of cylinder. Building made of concrete construction, it must be required corresponding the required strength through planning determined by testing the quality of concrete on the job mix SNI test standard, but in the process of concreting that does not be corresponding the method and the conditions that must be obeyed often results in strength the concrete construction that has been built does not achieve the desired strength. When the existing concrete building strength checks are carried out, it is necessary to evaluate how much the error or the difference in the results of the test on the concrete quality of the planning and quality of hard concrete that is ready to be built. For this reason, one of the hard concrete strength tests is done by using the core drill method.

1. Introduction
Job mix design is to provide information about the composition of sand, material / aggregate, water that can be used as a reference for making concrete of a certain quality (for example: f’c 15, f’c 25, f’c 30, etc.). The core drill method is a method of taking concrete samples on a building structure. Samples taken (cylindrical form) are then taken to the laboratory for testing such as compressive strength. The compressive strength test (ASTM C-39) from the sample above is usually better known as the "Core Concrete" test.

The compressive strength of concrete is the ability to receive the compressive force per unit area. Concrete compressive strength identifies the quality of a structure. The higher the level of the desired structural strength, the higher the quality of the concrete that must be produced. Quality control with Core Drill method has become mandatory to determine the accuracy of the concrete quality inspection, this method is considered the most reliable in determining the quality of concrete. But this method still has many weaknesses in determining the quality of concrete. It takes a lot of research about concrete Core Drill so that no party is harmed.

2. Literature review
2.1. General
It can be understood that concrete construction is generally better if the compressive strength is higher. Thus, to review the quality of concrete, it is usually roughly only observed its compressive strength, except in certain concrete structures where concrete must overcome tensile stress.
2.2. Compressive strength of concrete

In the theory of concrete technology, it is explained that the factors that greatly influence the strength of concrete are the cement water factor and density, Age of concrete, Type of cement, Amount of cement and Aggregate properties based on SNI 1974:2011, Test method of concrete compressive strength with cylindrical test object, the Compressive Strength of concrete is calculated by using the formula as following formula:

\[ f'c = \frac{P}{A} \]  

(1)

\[ f_{c} \]  

Figure 1. The illustration of compressive strength test.

If the ratio of length (L) to diameter (D) of the test object is less than 1.8, correct the results obtained by multiplying by the corresponding correction factor as in the following table:

| No | Ratio l/d | Correction Factor |
|----|-----------|-------------------|
| 1  | 2.00      | 1.00              |
| 2  | 1.75      | 0.98              |
| 3  | 1.50      | 0.96              |
| 4  | 1.25      | 0.93              |
| 5  | 1.00      | 0.87              |

2.3. Core drill method

This method is suitable for concrete quality checks for roads and bridges due to traffic. This method is mainly used for testing the surface of core drill specimens with a diameter of 100 mm, mortar specimens, or other concrete specimens with insufficient surface area when using the ASTM C 418 or ASTM C 779 test method. This test method can also be used for testing concrete surfaces in the field, as described in the ASTM C 779 test method, procedure B, item 9. A drill or other similar device whose drill head is able to hold and rotate the abrasion blade at a speed of 200 revolutions per minute and with a load (98 ± 1) N acting on the surface of the test object. There are difficulties in maintaining the load while using the wide system, the teeth and springs that are on the drill can be overcome by placing the desired load
directly above the drill shaft. This machine consists of a frame that supports the drive motor, pulleys and shafts.

This test method provides standardized procedures for obtaining and testing specimens to determine the compressive strength of in-place concrete. Generally, test specimens are obtained when doubt exists about the in-place concrete quality due either to low strength test results during construction or signs of distress in the structure. Another use of this method is to provide strength information on older structures.

Concrete strength is affected by the location of the concrete in a structural element, with the concrete at the bottom tending to be stronger than the concrete at the top. Core strength is also affected by core orientation relative to the horizontal plane of the concrete as placed, with strength tending to be lower when measured parallel to the horizontal plane. These factors shall be considered in planning the locations for obtaining concrete samples and in comparing strength test results.

The strength of concrete measured by tests of cores is affected by the amount and distribution of moisture in the specimen at the time of test. There is no standard procedure to condition a specimen that will ensure that, at the time of test, it will be in the identical moisture condition as concrete in the structure. The moisture conditioning procedures in this test method are intended to provide reproducible moisture conditions that minimize within-laboratory and between-laboratory variations and to reduce the effects of moisture introduced during specimen preparation.

A clamping device for holding the test object is mounted on the mounting device. Testing of concrete cylinder samples that are carried out during concreting above is not a direct method of concrete quality inspection, but only the control of concrete mix quality. More accurate and accurate data is when samples are taken from hard concrete in a concrete pouring place after the work is finished. Compaction methods which do not result in gravel nests or other forms of rock separation can be examined by the Core Drill method.

Bringing the test object (concrete cylinders) from the place of extraction to the testing laboratory must be taken not to damage, should be wrapped tightly with a waterproof material, glue tightly to prevent drying during the trip.

The compressive strength of this concrete test object is calculated up to 0.5 Mpa accuracy using the formula:

\[ f'c = \frac{P}{\pi \phi^2} \]  

(2)

In general, the results of testing are destructive, to determine the strength of the concrete in the field whether the concrete quality is still good or not. One way to find out the strength of concrete in the field by damaging this concrete structure is Coredrill.

Some things that need to be considered in taking concrete samples are as follows:

1. Concrete age of at least 14 days.
2. Sampling of concrete cylinders is carried out in areas with doubtful compressive strength, usually based on concrete sample test results from each part of the structure, or from the results of NDT (Non Destructive Testing) with concrete hammer or UPVT (Ultrasonic Pulse Velocity Test).
3. From one concrete area, one sampling point was taken. Sampling in buildings has long been established, so usually core drill is done on parts of concrete structural elements that want to know the compressive strength from one sampling taken 3 drilling points. Drilling must be in place that does not endanger the structure, for example, do not close the reinforcement joint, maximum moment and main reinforcement.
4. The test object that is defective because there are too many cavities, the presence of coarse loose debris / aggregates, loose iron reinforcement and dimensional irregularities, should not be used for determine the strength of the concrete.
5. The diameter of the test object for compressive strength test must not be less than 90 mm;
6. The ratio of the height of sample (L) with diameter (D) is greater or equal to 0.95, where L = length and D = diameter of the specimen;
7. Drilling must be perpendicular to the concrete surface.
8. Drilling holes must be filled with concrete of the same minimum quality.
9. If there is a content of iron reinforcement in the core concrete test object, its location must be perpendicular to the axis of the test object;
10. The amount of iron reinforcement content in the core concrete test object must not exceed 2 sticks;
11. If the amount of iron reinforcement content in the core concrete test object is more than 2 sticks, the test object must be done with a concrete saw and grinding, so that it meets the requirements and if it is not met, the test object must not be used for compressive strength test.

3. Research methodology

In general, this research methodology is divided into 4 main stages. They are preparation stage, test object making phase, testing phase, evaluating the test results of job mix sample and Core Drill test sample.

3.1. Testing mechanism

This study was preceded by a literature study of related journals and books. Then the sample was made, designed the concrete of the ordinary job mix specimen and the concrete specimen for the core drill, after which the concrete was cast, both the job mix with the same quality and manufacturing procedures. Job mix Test sample are made in the form of Concrete cylinders and the sample for Core are made in the form of Concrete blocks prepared for Core by using Core Drill Tools. Test objects Concrete results from Core Drill and Job mix Concrete were tested for compressive strength with a Compression machine in the Laboratory. The ends of core specimens to be tested in compression shall be flat, and perpendicular to the longitudinal axis in accordance with Test Method C39/C39M. If necessary, saw the ends of cores that will be capped so that prior to capping.

If the ends of the cores do not conform to the perpendicular requirements of test Method C39/C39M, they shall be sawed or ground to meet those requirements or capped with bonded caps in accordance with Practice C617/C617M. If the ends of the cores do not conform to the planeness requirements of Test Method C39/C39M, they shall be sawed or ground to meet those requirements or capped with bonded caps in accordance with Practice C617/C617M or tested with unbounded caps in accordance with Practice C1231/C1231M. If cores are capped in accordance with Practice C617/C617M, the capping device shall accommodate actual core diameters and produce caps that are concentric with the core ends. Measure core lengths to the nearest 1 mm [0.1 in.] before capping.

If the core will be tested with bonded caps, determine the average length before and after capping, and use the length after capping to compute the length diameter ratio (L/D). If the core will be tested with unbounded caps or with ground ends, determine the average length of the prepared core before testing. Determine the average length of the core to the nearest 1 mm [0.05 in.] using the jaw calliper procedure of Test Method C1542/C1542M or the procedure in Test Method C174/C174M. Determine the average diameter by averaging two measurements taken at right angles to each other at the mid-height of the core.

The measured compressive strength of a core will generally be less than that of a corresponding properly moulded and cured standard cylinder tested at the same age. For a given concrete, however, there is no unique relationship between the strengths of these two types of specimens. The relationship is affected by many factors such as the strength level of the concrete, the in-place temperature and moisture histories, the degree of consolidation, batch-to-batch variability, the strength-gain characteristics of the concrete, the condition of the coring apparatus, and the care used in removing cores. Samples of hardened concrete for use in the preparation of strength test specimens shall not be taken until the concrete is strong enough to permit sample removal without disturbing the bond between the mortar and the coarse aggregate. When preparing strength test specimens from samples of hardened concrete, samples that have been damaged during removal shall not be used unless the damaged portion are removed and the lengths of resulting test specimens satisfy the minimum length-diameter ratio requirement (based on Table 1).
4. Results

4.1. The testing result compressive strength of concrete

Table 2. The testing result compressive strength of concrete sample.

| No | Sample Code | Information                                                                 | Compressive Strength |
|----|-------------|------------------------------------------------------------------------------|----------------------|
|    |             |                                                                              | (MPa) Kg/cm²         |
| 1  | JMS 10      | Test objects treated in the laboratory, cylinders (d=10; t=20)              | 18.62 228.75         |
| 2  | JMS 15      | Test objects treated in the laboratory, cylinders (d=15; t=30)              | 19.08 234.40         |
| 3  | CDS 10      | Core test specimens placed inside the room and soaked, cylinders (d=10; t=20)| 16.81 206.57         |
| 4  | CDS 15      | Core test specimens placed inside the room and soaked, cylinders (d=15; t=30)| 13.70 168.26         |
| 5  | CDTC 10     | Core Test specimens placed inside the room without curing, cylinders (d = 10; t = 20) | 13.65 167.75         |
| 6  | CDC 10      | Core Test specimens placed inside the room with curing, cylinders (d = 10; t = 20) | 15.77 193.69         |
| 7  | CDJ 10      | Core Test specimens placed outside the room without curing, cylinders (d = 10; t = 20) | 14.69 180.47         |

![Figure 2](image_url)  
**Figure 2.** Graph of compressive strength test results with d = 15 cm, t = 30 cm (MPa).

![Figure 3](image_url)  
**Figure 3.** Graph of compressive strength test results with d = 10 cm, t = 20 cm (MPa).
4.2. Discussion on testing result
From the test results, it is known that:
1. There is a significant decrease in compressive strength in drill core samples compared to Test Sample treated in the laboratory.
2. Differences in treatment / treatment of the sample also affects the strength of the sample.
3. Core Drill specimens compared to Standard Test Sample tend to produce lower strength, meaning that there are disturbance factors that occur during the process of taking Core Drill specimens.

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