Journal of Civil Engineering Researchers

J-Researchers

JOURNAL OF CIVIL ENGINEERING RESEARCHERS

A review of the effect of the behavior of core diameter varing H/D ratio on concrete core strength

Allahyar Mohammad Alizadeh [a *]

[a] *Islamic Azad University, Chalous, Iran*

Abstract

In this review, we study the effect of H/D ratio of core diameter on concrete core strength. It has been shown that the compressive strength of cylinderical concrete specimen grows up as the height –to-diameter ratio decreases. In fact, the strength correction factors are responsible for evaluating this feature shown in ASTM C42 and BS1881 although we can not apply it to high-strength concrete over 40 MPa. For this purpose, concrete core specimens of 100 mm diameter were cut into different lengths with respect to the following height-to-diameter ratios 1.0,1.25, 1.5, 1.75 and 2.0. The results showed that strength reduces when L/D ratio rises. Also, for various strength classes, the correction coefficients of L/D are different.

Keywords: Core, Compressive strength, Correction coefficients, Aggregate size,

1. Introduction

The compressive strength test is referred to as the most conventional test on concrete. However, this test doesn't show the strength in structural member. Owning to the fact that the impact of placement, compaction and curing of concrete are different from the existing condition in structure. At first, in order to do the project, the specimen taken from the concrete. There is something to mention that the strength of standard specimens is determined at age of 28 days. Having been provided at the lower ages, it is not feasible to determine strength. The most noticeable fact regarding data is that sometimes there are not data about a structure or the data are doubted for some reasons. In such cases, in-situ tests are a necessity [1].

Among in-situ tests, core test as a semi-destructive is one of the most precise and crucial tests in-place tests. It has been reported that coring is extremely expensive and slow test among in-place tests while its precision and reliability are remarkably high. In core testing, standard size has at least the diameter of 100mm; nevertheless, due to the small members or

* Corresponding author. e-mail: alfa_3707@yahoo.com

rebar, cores with smaller than 100mm are applied by researchers in practice [2].

There are so many effective factors and parameter on core strength. The most striking points that these parameters hold great significance regarding cores with small diameter are as: (1) length-to-diameter ratio (L/D); (2) core diameter; (3) concrete strength level; (4) type and size of aggregate; (5) moisture conditions at the time of testing; (6) core drilling direction; (7) location of core; (8) the presence of reinforcement steel bars in the specimen [3].

It has proven that for a given diameter of core, measured compressive strength will vary with length. The most considerable fact in this regard is that under test, the shape of the test specimen affects the stress distributions. Besides, for cores having l/d lower than 2.0, strength grows with the decrease in l/d. Therefore, in order to obtain the corrected strength which is on parity with the standard l/d conditions, the higher strength of cores of lower l/d ratios must be corrected by factors developed for each ratio [4].

The ASTM C 42-90, AASHTO T 22 and BS1881: Part 120: 1983 standard provision ([5], [6]) indicate correction factors for concrete strengths, shown in Tab.1. Conversion factors are seen in the AASHTO and ASTM codes for estimating strength test results for h/d < 1.8. These factors turn strength test results into equivalent results for a specimen having h/d = 2.

Table1: Standard correction factors for strength of cylinders with different ratios of height to diameter

Height to diameter ratio (h/d)	Strength correction factor	
	ASTM C 42-90 AASHTO T 22	BS 1881.Part 120
2.00	1.00	1.00
1.75	0,98	0.97
1.50	0.96	0.92
1.25	0.93	0.87
1.00	0.87	0.80

Generally, these factors used for tests on cores are taken from structures that it is impossible to obtain the ratio h/d = 2 for specimens. In 1957, Murdock and Kesler have reported the dependence of correction factor on the strength level of the concrete.

In this review paper, the basis of recent studies on the effect of core diameter varying H/D ratio on concrete core strength has been presented and discussed. Finally, we conclude and summarize our results.

2. Literature Review

In 2008, an experimental research conducted by Tuncan et al evaluated cylinderical concrete cores with 46 and 69 mm diameters and values changing from 0.75 to 2.0. Using aggregates with different types and sizes, these cores were obtained from concrete blocks constructed in the laboratory environment. The most telling conclusion to be drawn is that the compressive strength of concrete falls as the maximum aggregate size increases. For example, for two cylindrical concrete specimens with 46 mm diameter and =2.0, the relative strengths of 46 mm diameter cores with respect to standard cylinder specimen were 85 % and 72 % for cores drilled from natural aggregate-bearing concretes produced by 10 and 30 mm maximum sizes of aggregates, respectively [7].

In 2010, Seko et al carried out an experiment to test compressive strength. They estimated the strength correction coefficients and examined the fracture behavior of high-strength concrete cores of compressive strength in the range of 30-100MPa. In this test, concrete core specimens were cut into different lengths with respect to the following height-to-diameter ratios ranging from 1.0, 1.25, 1.5, 1.75 and 2.0. At the second step, during testing, strains along the horizontal and axial directions were calculated. The worth noticing results to be drawn is that critical volume change stress is approximately 0.85 of the compressive strength for all H/d and all strength grades. In addition, compressive strength of concrete core specimens increases with the reduction of height-to diameter. The reason behind this result is the emergence of critical volume change stress [8].

In 2012, Ergun et all investigated the effects of diameters, length to core diameter ratio (=L/D), test age, and coring orientation on the compressive strength of cores analyzed with respect to the molded cylinder and cube concrete specimens[9].

In an intriguing research in 2013 by Sharma et al, they make an effort to find the effect of H/D ratio on the strength characteristics of the core. Cubes of 150mm x 150mm x 150mm were casted and cured for 28 days, desired core samples having diameter 50mm and 75 mm were prepared from these cubes having different H/D ratios of 1, 1.25, 1.5, 1.75 and 2, respectively. In this work, for each mix, the average values of measured core strength were compared for each different value of H/D and expressed in terms of a core with H/D = 2.0. Based on the results obtained for H/D ratios an over-at least-squares, regression was performed. For small cores of 50 and 75 mm diameters, the following conclusion may be drawn: (1) The compressive strength of cores increased with the decrease in H/D ratio of the core. (2) The effect of H/D ratio was more pronounced for 50 mm diameter cores [10].

In 2015, the effect of diameter, length-to-diameter ratio (L/D), maximum aggregate size, drilling direction and concrete strength level was evaluated by Madandoust et al, The tests on cores with diameters 50, 75, 100mm at 28 days are performed with L/D as 1, 1.4, 1.6, 2 and two strength classes as C1, C2. The relationship between core strength and 15cm standard cube samples was estimated [11]. The following result are drawn: (1) With the increase of L/D ratio of core, core strength was reduced and these changes of core strength were more pronounced in low strength class concrete (C1). (2) It seems that correction coefficients of L/D of core in low strength class concrete in core with various diameters are close to BS1881 [6] curve and for high strength class concrete are close to ASTM C 42-90 curve [5].

3. Discussion and Conclusion

In this work, we have reviewed the recent studies in which measured strength core will change with the proportion of the ratio of length to diameter of the core. Standard cores have a ratio of length to diameter which is equal 2. But, due to the low thickness of the concrete, the production of core samples with L / D = 2, particularly for larger diameter cores is not possible. Because of the difference in modulus of elasticity and Poisson's ratio of steel and concrete, concrete specimen and steel plate tend to deform unequal lateral parts. However, because of friction, relative lateral movement between steel planes and concrete specimens is not feasible in the contact surface and, consequently, shear stresses will arise in this region. The effect of these stresses can be seen clearly in standard cylinderical samples. Thus, at the end of specimen, a con remains with a height 0.86D (D diameter of the cylinder), but, among these cones, free side change is something that can be emerged by blowing out in the middle part of the cone. Also, in the cylindrical specimen (L / D = 1), intact pyramids are created, but because of height limitation, vertices in the pyramids overlap so that the area where the lateral deformation can be free to be removed. As a result, it is impossible to create uniaxial compression; therefore, to determine the actual uniaxial compressive strength of concrete, cylindrical specimen with a ratio of height to diameter greater than the 1.7 should be used. In the standard cylinder, the ratio of height to diameter is 2. There is subtle point should be considered that by increasing the strength of concrete, the tangential stresses will have less impact due to the fact that concrete and steel may have closer stiffness together. Thus, the results of concrete strength in length to the different diameters approach together [12].

To sum up, a commonly held believe by most researchers is that by increasing the length to diameter ratio of core, core strength is reduced .

References

[1] Khalu A., Amiri H.(2001), The relationship between strength of core and cylinder sample (for strengths to 450kg/cm2),the 1st international conference of concrete and development. Tehran. April. 2001.

[2] Tuncan,M.,Arioz,O.,Ramyar,k.,B.(2006) ,Assessing concrete strength by means of small diameter cores, Journal of Construction and Building Materials,2006,pp:981-988.

[3]Tarun,R.Naik, (1990), Variation in concrete core strength, Report No.CBU-1990-13, Department of Civil Engineering and Mechanics College of Engineering applied Science, The University of Wisconsin-Milwaukee, 1990.

[4]Yip, W. K. and Tamt, C. T. [1988], "Concrete Strength Evaluation Through the Use of small Diameter Cores", Magazine of Concrete Research, Vol. 40, No. 143, June 1988, pp. 99-105.

[5]ASTM C 42-90, Standard test method for obtaining and testing drilled cores and sawed beams of concrete, ASTM, U.S.A., 1992.

[6]BS-1881-120: Testing concrete method for determination of the compressive strength of concrete cores, British Standards Institute, 1983.

[7]Tuncan, M., Arioz Ö., Ramyar K. and Karasu B. Assessing concrete strength by means of small diameter cores. Construction and Building Materials, 22: 981-988, (2008).

[8]Seko,sh.,Suzuki,s.,Ito,y.,Kage,t., (2010), Effect of Fracture Behavior and Height-to-diameter Ratio on High-Strength Concrete Core Specimens , Proceeding of FraMcos,Vol.7, May 23-28 ,pp:725-729.

[9]Ergun,A.,Kurklu,G.(2012) ,Assessing the Relationship between the Compressive Strength of Concrete Core and Molded Specimens,2012,pp:737-750.

[10]Sharma,S.,Aggarwal,P.K.and Naval,S.(2013) ,Experimental Study Of Core Diameter Varing H/D On Concrete ,International journal of Engineering Research @Technology, Volume.2,Issue.3,March 2013.

[11]Madandoust R.,Mohammad Alizadeh A.(2015), Assessing the Effective Parameters on Normal Strength Concrete by Core Testing. Vol.3,Issue 2,Dec 2015,pp:17-21

[12]Keynia, A.M.(1999), Analysis and design of reinforcement concrete. 8th edition. Jahad Daneshgahi publications, Industrial branch of Isfahan.