Construction and Building Materials xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Slant shear bond strength between self compacting concrete and old concrete

Ahmed M. Diab [a], Abd Elmoaty M. Abd Elmoaty [a], Mohamed R. Tag Eldin [b,*]

[a] Structural Engineering Department, Faculty of Engineering, Alexandria University, Egypt
[b] Civil Engineer, Master of Engineering Student, Faculty of Engineering, Alexandria University, Egypt

HIGHLIGHTS

- This work presents factors affecting bond strength between SCC and old concrete.
- Cylindrical specimens (150 × 300 mm) have minimum coefficient of variation.
- Roughness of substrate concrete has a significant effect on bond strength.
- Composition of SCC have a significant effect on bond strength.
- Prism specimens represent more reliable bond strengths.

ARTICLE INFO

Article history:
Received 17 January 2016
Received in revised form 19 August 2016
Accepted 5 November 2016
Available online xxxx

Keywords:
Self compacting concrete
Slant shear bond strength
Concrete compressive strength
Interface properties
Latex and polypropylene fiber

ABSTRACT

This experimental investigation aims to study the bond strength between old and new self-compacting concrete (SCC). The first part presents the factors affecting slant shear bond strength between old concrete and new self-compacting concrete. The studied parameters are compatibility between old concrete and new SCC through variation of concrete compressive strength and concrete stiffness, type of bonding agent, roughness of old concrete, and the effect of adding latex and polypropylene fiber to self-compacting concrete. In the second part, the proper specimen of slant shear test is studied. From the test results, cylindrical specimens with 150 mm diameter and 300 mm height have a minimum coefficient of variation compared with other studied shapes. The concrete compressive strength overlay self-compacting concrete, roughness of old concrete configuration, adding latex and using polypropylene fiber have a significant effect on slant shear bond strength. In addition, the prism specimen represents more reliable value of slant shear strength than cylinder specimen.

1. Introduction and research significance

Bond strength between old and new concrete is a very important factor in repairing process. This topic was studied for traditional vibrated concrete for old and overlay concrete. There is a lack of information about the behavior of self-compacting concrete as an overlay concrete.

The success of repairing and strengthening process of reinforced structure depends on the quality of bonding between old and new concrete. So, it is important to evaluate the bonding strength between old and new concrete [1]. There are a lot of available tests that can evaluate bond strength between old-new concrete. Many researches discussed this issue and most of them classify the tests into three categories. These categories are direct tension stress test, direct shear stress test and shear combined with compression stress test (slant shear test). Slant shear test is the most popular test method used in laboratory to estimate bond strength between old and new concrete.

The slant shear test was proposed in 1976 using cylindrical shape specimens of 150 mm diameter and 300 mm in height, in 1978 this test was adopted by Tabor using prismatic specimens. Table 1 shows available standards for slant shear test. The test was modified by Saldanha et al. [2]. Saldanha et al. suggested using steel bars in both halves of the modified slant shear test.

Slant shear test is used to determine the bond strength between two types of concrete. Also, this test method covers the determination of the bond strength of epoxy-resin-base bonding systems for use with Portland-cement concrete.

There are many factors affecting bond strength between old and new overlay concrete. These factors include concrete compressive strength of old (base) and new overlay concrete, roughness of base

* Corresponding author.
E-mail address: m.rtageldin@yahoo.com (M.R. Tag Eldin).

http://dx.doi.org/10.1016/j.conbuildmat.2016.11.023
0950-0618/

Table 1
Available standards for slant shear test.

Standard	Cross section	Total height (mm)	Angle with the vertical
BS EN12615	100x100 mm	400	30°
BS EN12615	40x40 mm	160	30°
NEP18-872	100 × 100	300	30°
ASTM C882	75 mm diameter	150	30°

concrete, curing, moisture state of interface [1–7]. The effect of using pozzolanic materials on overlay concrete and effect of bonding agent were also studied by Zhifu Wan [7] and Adel Elkurdi [8]. SCC is a high performance concrete that can be placed into formwork between steel bars under own weight and it fills restricted section without the need of any mechanical compaction and improve high workability, passing ability and high deformability [9]. The previous factors were studied only for old (base) and new concrete as traditional vibrated concrete and insufficient data about these factors for new overlay self-compacting concrete.

This research work aims to study the effect of compressive strength of old and new overlay self-compacting concrete and the roughness of interface on slant shear bond strength. Different roughness configurations are proposed. The effect of coarse aggregate type (concrete stiffness), adding styrene butadiene rubber as a latex and polypropylene fiber are also considered. The proper slant shear test specimen is captured using the experimental test results of this research and literature using Walter mode of failure.

2. Experimental program

2.1. Materails

Natural aggregate, ordinary Portland cement, chemical admixtures, silica fume, bonding agents, polypropylene fibers and potable water were used throughout the research work. The used coarse aggregates were crushed limestone stone with nominal maximum size of 10 mm and gravel with nominal maximum size of 10 mm. Sand with 2.68 fineness modulus was used. The sieve analysis, ASTM C 33 limits and properties of used aggregate are given in Tables 2 and 3. An ordinary Portland cement according to ASTM C 150 was used throughout this research. Type G chemical admixture according to ASTM C494 was used. Silica fume as a filler material was used in the production of self-compacting concrete. The used bonding agents in this study were latex based on styrene butadiene and epoxy resin. Polypropylene fiber with 12 mm length and 18-μm diameter was used to produce fiber concrete.

2.2. Studied parameters

The studied parameters in this research work were the effect of specimen geometry, flow diameter of self-compacting concrete, concrete compressive strength, different stiffness between old and new concrete, substrate concrete surface roughness, effect of using the bonding agents, effect of adding latex and effect of using polypropylene fiber. The first parameter was done first to choose the most suitable test specimen which yields the minimum variation in slant shear strength test results. The selected specimen shape was used for the rest studied factors. The details of these factors are presented in the following sections. All conventional base concrete specimens were left at least 28 days before overlay concrete was cast.

Table 3
Properties of used aggregates.

Properties	Coarse aggregate		Sand
	Pink limestone	Gravel	
Unit weight (t/m^3)	1.51	1.69	1.70
Specific gravity	2.50	2.6	2.60
Percentage of fine material less than No. 200 sieve by washing	1.0	1.0	1.7
Percentage of absorption	1.8	0.4	–
Abrasion by loss angles	18.0	10	–

2.2.1. Effect of geometry of test specimen

Two different shapes of specimen were used (cylinders and prisms). Two sizes of each shape were used. The standards of these specimens and their details are presented in the Table 4. In this parameter, the base concrete (old) was conventional concrete with 25 MPa cube compressive strength and overlay (new) was SCC with 35 MPa cube compressive strength. The average flow diameter of SCC mixes was 640 mm. Pink limestone was used as coarse aggregate in conventional and SCC production. The interface surface between base and overlay concrete was saturated state and roughened by hand brush. Five specimens were used for each test. The testing ages were 7 days and 28 days.

2.2.2. Effect of flow diameter of SCC

According to ACI 237 the flow diameter should be between 550 and 750 mm. Three flow diameters were considered. These diameters were 640 mm, 700 mm and 810 mm. Compressive strength of base concrete and overlay SCC were 25 MPa and 35 MPa. The used coarse aggregate for base concrete and overlay SCC was pink limestone. Conventional vibrated compacted concrete was used as an overlay concrete with 35 MPa compressive strength for comparison.

2.2.3. Effect of compressive strength of overlay SCC

Four grades of self-compacted concrete compressive strength were studied. The used 28 days compressive strengths were 25 MPa, 35 MPa, 37 MPa and 42.5 MPa. The average flow diameter of SCC mixes was 640 mm.

The 28 days concrete compressive strength for base (conventional concrete) concrete was kept constant of 25 MPa.

Table 2
Sieve analysis of coarse aggregate and Sand.

Sieve size (mm)/No.		12.5	9.5	4.75	2.36	1.18	No.4	No.8	No.16	No.30	No.50	No.100
Coarse aggregate grading	Pink limestone passing %	100	99	36	1	0	0	0	0	0	0	0
	Gravel passing %	100	100	36	1	0	0	0	0	0	0	0
Coarse aggregate ASTM C 33limits	Max.	100	100	30	10	0	0	0	0	0	0	0
	Min.	100	85	10	0	0	0	0	0	0	0	0
Sand grading	Sand passing %	100	100	100	100	100	97.9	94.2	82.6	43.6	8.7	5.4
Sand ASTM C33 limits	Max.	100	100	100	100	100	100	100	85	60	30	10
	Min.	100	100	100	100	100	95	80	50	25	10	2

Please cite this article in press as: A.M. Diab et al., Slant shear bond strength between self compacting concrete and old concrete, Constr. Build. Mater. (2016), http://dx.doi.org/10.1016/j.conbuildmat.2016.11.023