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Study of Destructive and Non-Destructive Test for Codal Base Minimum Grade of Concrete

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Abstract

The use of NDT increase safety and allows better schedules of construction thus making it possible to progress faster and economical. In this project the study of destructive and non-destructive test on concrete specimen. The destructive test taken on cube, cylinder and beam. The non-destructive test taken on cube, cylinder and beam. From the non-destructive test found out the accurate result of the concrete strength. Today modern non-destructive tests are used in manufacturing, fabrication and in service inspections to ensure product integrity and reliability, to control manufacturing processes, lower production costs and to maintain a uniform quality level. During construction, NDT is used to ensure the quality of materials and joining processes during the fabrication and erection phases, and in service NDT inspections are used to ensure that the products in use continue to have integrity necessary to ensure their usefulness and the safety of the public. It should be noted that while the medical field uses many of the same processes, the term NDT is generally not used to describe medical application. NDT is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system. In other words, when the inspection or test is completed the part can still be used. In contrast to NDT, other test is destructive in nature and are therefore done on a limited number of samples, rather than on the material, components or assemblies actually being put into service. These destructive tests are often used to determine the physical properties of materials such as impact resistance, ductility, yield and ultimate tensile strength, fracture toughness and fatigue strength, but discontinuities and differences in material characteristics are more effectively found by NDT.

Keywords—Non-destructive and Destructive test

I. INTRODUCTION

An important feature of non- destructive test is that they permit re- testing at the same, or nearly the same, location so that changes with time can be monitored. The use of non – destructive tests leads to increased safety and allows better scheduling of construction, thus making it possible to progress faster and more economically. Broadly speaking, these tests can be categorized into those that assess the strength of the concrete in situ, and those that determine other characteristics of the concrete such as voids, cracks, and deterioration. With respect to strength, it should be noted that it can be only assessed, that not measured, because the non-destructive test is, the most part, comparative in nature. Thus it is useful to established an experimental relation between the property being measured by a given test and the strength of the test specimens or cores from the actual concrete; there after this

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relation can be used to converted the nondestructive test results into strength value. An understanding of the physical relation between the given nondestructive the results and strength is essential. This relation for the various test will be discuss in what follows. One more general comment about the interpretation of the results of non-destructive test is necessary. The test rarely given a number which can be unequivocally interpreted engineering judgment is necessary. Otherwise there is risk that one part is or another will seek addition test and the dissipate about the concrete in the structure will be compounded by a dissipate about the testing. Helpful advice about planning non-destructive testing is given in BS 1881: Part 201:1986, and BS 6089:1981 give a guide to the assessment of concrete strength in existing structure.
Importance and need of non-destructive testing:
It is frequently necessary to test concrete structures after the concrete has hardened to determine whether the structure is suitable for its designed use. such type of testing should be done without damaging the concrete. The range of properties that can be measured using non-destructive tests and partially destructive test is completely large and includes such fundamental parameters as density, elastics modulus and strength as well as surface hardness and surface absorption, and reinforcement location, size and distance from the surface.

II. OBJECTIVE

1. To determine the strength of concrete by considering DT and NDT Test.
2. To study the strength parameter of concrete.
3. To determine the suitable and faster NDT Methods.
4. The different percentage strength variation for replacement of fly ash to the concrete.
5. To compare different bond strength of a concrete.
6. Comparing Codal strength of a concrete with the experimental MIX MATERIALS

The material details are as follows

A. *Cement*
For this experimental work is “Ultratech 53 grade Ordinary Portland Cement” is used. also All properties of cement are tested by using IS 12269 - 1987 Specification for 53 Grade Ordinary Portland Cement.

B. *Water*
Drinkable water available in laboratory is used for mixing & curing of concrete.

C. *Fine Aggregate*
for this experiment Locally available fine aggregate of size 4.75 mm size confirming to zone II with specific gravity 2.66 is used. The testing of sand was conducted as per IS: 383-1970.Water absorption and fineness modulus of fine aggregate was 1.35% and 2.80 respectively

D. *Coarse Aggregate*
Coarse aggregate used was 20mm and less size with specific gravity 2.70. Testing of coarse aggregate was conducted as per IS: 383-1970. Water absorption and fineness modulus of coarse aggregate was 0.7% and 6.01 respectively.

E. *Fly Ash*
Fly Ash (FLA) is available in dry powder form and is procured from Dirk India Pvt. Ltd., Nasik. It is available in 30Kg bags, colour of which is light grey under the product name "Pozzocrete 60".

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III. EXPERIMENTAL WORK AND TEST

DESTRUCTIVE TEST CONDUCTED ON CONCRETE

In present study cube compression test, flexural test on beams and Cylindrical split tensile test on self-compacting concrete with constant fraction of steel fibre were carried out.

A. Compressive Strength Test

A cube compression test is performed on standard cubes of size 150 x 150 x 150 mm after 3, 7 and 28 days of immersion in water for curing. The compressive strength of specimen is calculated by the following formula:

fcu = Pc /A

Where

Pc = Failure load in compression, KN

A = Loaded area of cube, mm2

B. Split Tensile Test

The split tensile test is well known indirect test used to determine the tensile strength of concrete. Due to difficulties involved in conducting the direct tension test, a number of indirect methods have been developed to determine the tensile strength of concrete. In this tests, in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses induced in the specimen.

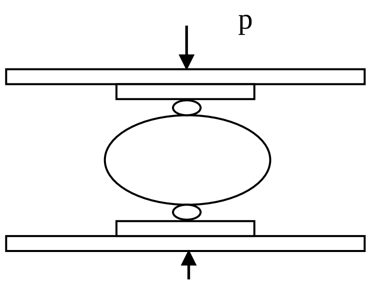

Fig 1 Cylinder split tensile test setup

The split tensile strength of cylinder is calculated by the following formula,

$$f_t = 2P / \pi L D$$

Where,

ft = Tensile strength, MPa

P = Load at failure, N

L = Length of cylinder, mm

D = Diameter of cylinder, mm

C. Flexural Test:

Standard beams of size 150 x 150 x 700mm are supported symmetrically over a span of 400mm and

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subjected two points loading till failure of the specimen. The deflection at the centre of the beam is measured with sensitive dial gauge on UTM. The two broken pieces (prisms) of flexure test are further used for equivalent cube compressive strength.

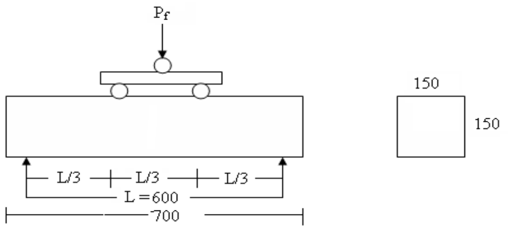

Fig 2 Two-point loading setup in flexure test

(All Dimensions are in mm)
The flexural strength is determined by the formula

f_{cr} = Pf L / bd2

Where,

f_{cr} = Flexural strength, MPa
Pf = Central point through two-point loading system, KN
L = Span of beam, mm
b = Width of beam, mm
d = Depth of beam, mm

Non Destructive test conducted on Concrete

A. Rebound Hammer:

The most commonly used surface hardness procedure is the standard rebound hammer test. The test was developed in 1948 by Swiss engineer Ernst Schmidt and is commonly referred to as the Schmidt Rebound Hammer (Kolek, 1969). Upon impact with the concrete surface, the rebounded hammer records a rebound number which presents an indication of strength properties by referencing established empirical correlations between strength properties of concrete (compressive and flexural) and the rebound number.

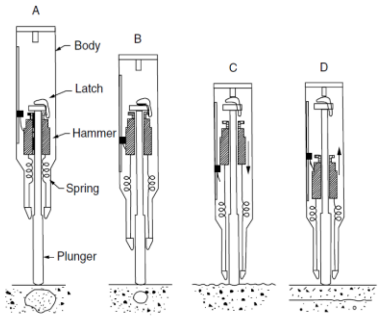

Fig 3 Rebound hammer

B. Ultrasonic Pulse Velocity Methods

The method is based on measuring the velocity of compression stress waves P-waves. The pulse velocity is related to Young's modulus of elasticity by the well-known law

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$$Vp=\sqrt{\frac{Ed}{\rho}}\,f[v]$$

Where

Vp = velocity of compressional stress waves

Ed = dynamic Young's modulus of elasticity;

ρ = mass density

υ = Poisson's ratio

f (v) = function dependent on the shape and dimensions of the solid

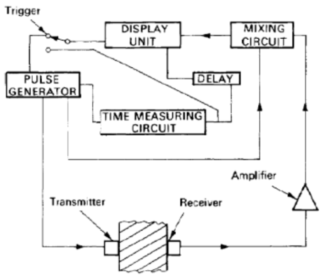

Fig 4 Typical UPV Testing Equipment

C. Pull-Out Bond Test:

Pull-out resistance methods measure the force required to extract standard embedded inserts from the concrete surface. Using established correlations, the force required to remove the inserts provides an estimate of concrete strength properties. The two types of inserts, cast-in and fixed-in-place, define the two types of pull-out methods. Cast-in tests require an insert to be positioned within the fresh concrete prior to its placement. Fixed-in-place tests require less foresight and involve positioning an insert into a drilled hole within hardened concrete.

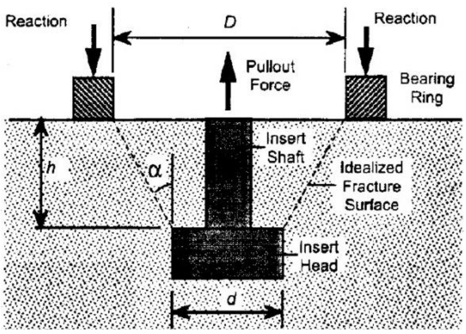

Fig 5 Pull out test

IV. CASTING AND TESTING

Compressive strength test for cube

Tab. No. 1 Compressive strength test for cube 28 Days

Sr. No.	**% of Fly Ash**	**C/s Area (mm^2)**	**Load (KN)**	**Compressive Strength (N/mm^2)**	**Avg. Compressive Strength (N/mm^2)**

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1.	0%	22500	612.55	27.2	27.13
2.			618.05	27.4	
3.			603.00	26.8	
4.	10%	22500	624.10	27.73	27.65
5.			622.35	27.66	
6.			620.15	27.56	
7.	20%	22500	636.55	28.29	28.41
8.			642.25	28.54	
9.			639.65	28.42	
10.	30%	22500	656.00	29.15	29.28
11.			658.20	29.25	
12.			662.45	29.44	
13.	40%	22500	610.30	27.12	27.03
14.			606.75	26.96	
15.			608.00	27.02	
16.	50%	22500	604.05	26.84	25.35
17.			600.25	26.66	
18.			508.00	22.57	

Split Tensile Test for cylinder

Tab. No. 2 Split Tensile Test for cylinder 28 Days

Sr. No.	**% of Fly Ash**	**Load at Failure (KN)**	**Tensile Strength(N/mm2)**	**Average Tensile Strength(N/mm2)**	**Remark**
1.	0%	252	3.56	3.53	As per clause no.6.2.2-page no. 16 of IS: 456-2000 Split Tensile Strength of M20 grade concrete is **3.13 Mpa**
2.		250	3.53		
3.		248	3.50		
4.	10%	254	3.59	3.61	
5.		256	3.62		
6.		258	3.64		
7.	20%	260	3.67	3.71	
8.		262	3.70		
9.		266	3.76		
10.	30%	278	3.93	3.93	
11.		276	3.90		
12.		280	3.96		
13.	40%	246	3.48	3.45	
14.		244	3.45		
15.		242	3.42		
16.	50%	240	3.39	3.36	
17.		238	3.36		
18.		236	3.33		

Flexural Test on beam

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Tab. No. 3 Flexural Test on beam 28 Days

Sr. No.	% of Fly Ash	Load at Failure (kN)	Flexural Strength (N/mm2)	Average Flexural Strength (N/mm2)	Remark
1.	0%	18	3.73	3.72	As per clause no.6.2.2 page no. 16 of IS: 456-2000 Flexural Strength for M20 grade concrete is **3.13MPa**
2.		20	4.14		
3.		16	3.31		
4.	10%	19	3.94	3.86	
5.		20	4.14		
6.		17	3.52		
7.	20%	22	4.56	3.93	
8.		16	3.31		
9.		19	3.94		
10.	30%	20	4.14	4.55	
11.		22	4.56		
12.		24	4.97		
13.	40%	15	3.11	3.24	
14.		18	3.73		
15.		14	2.90		
16.	50%	14	2.90	2.89	
17.		16	3.31		
18.		12	2.48		

Rebound Hammer Test

Tab. No. 4 Rebound Hammer Test

Sr. No.	% of Fly Ash	Rebound No.	Comp. Strength (N/mm^2)	Avg. Comp. Str. (N/mm^2)
1.	0%	37	28	26.66
2.		36	26	
3.		36	26	
4.	10%	39	32	30.00
5.		38	30	
6.		37	28	
7.	20%	40	33	31.66
8.		38	30	
9.		39	32	

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10.		42	38	
11.	30%	40	33	37.00
12.		43	40	
13.		35	24	
14.	40%	34	22	25.33
15.		32	20	
16.		34	22	
17.	50%	32	20	22.00
18.		35	24	

Ultrasonic Pulse Velocity Methods

Tab. No. 5 Rebound Hammer Test

Sr. No	% of Fly Ash	Transit Time In Micro Sec	Path Length In mm	Pulse Velocity By Cross Probing	Avg. Pulse Velocity (km/Sec)
1.		41	150	3.65	
2.	0%	40	150	3.75	3.65
3.		42	150	3.57	
4.		40	150	3.75	
5.	10%	38	150	3.94	3.69
6.		44	150	3.40	
7.		44	150	3.40	
8.	20%	38	150	3.94	3.83
9.		36	150	4.16	
10.		35	150	4.28	
11.	30%	38	150	3.94	4.21
12.		34	150	4.41	
13.		40	150	3.75	
14.	40%	41	150	3.65	3.65
15.		42	150	3.57	
16.		42	150	3.57	
17.	50%	44	150	3.40	3.54
18.		41	150	3.65	

Pull out Test

Tab. No. 6 Pull out Test

Sr. No.	Specimen	% of Fly Ash	Load (kN)	Pull Out Strength (N/mm^2)
1		0 %	128	4.06
2		10%	134	4.25
3	Cube	20%	138	4.38
4		30%	146	4.64
5		40%	126	4.01

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6		50%	124	3.84

V. CONCLUSION

1. Non Destructive material testing is extremely effective means for the manufacturer or operator of a technical plant to quickly draw a firm conclusion about the quality of his product or the condition of his plant.
2. Using combine method of ultrasonic pulse velocity and rebound hammer gives better result than the only ultrasonic pulse velocity method.
3. The replacement of cement by fly ash in concrete also increases the rebound hammer test strength of concrete. It is clear that Compressive strength obtained from the rebound hammer test is excellent and increases with increment of Fly Ash up to 30%.
4. Velocity of an ultrasonic pulse passing through the concrete is more than 3.5 km/second which suggest that concrete quality is good. Due to good filling effect voids from the concrete reduces which increases velocity of ultrasonic pulse fly ash concrete.
5. The pull-out strength increases with the percentage increase of fly ash in concrete Beam. An increase of 4.67%, 7.88% and 14.28% strength was observed for 10%, 20% and 30% replacement of cement with fly ash respectively.

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