Assessment of compressive strength class of recently supplied concrete using in-situ Indirect testing plus selected core test data

1. Introduction

There are times when it is considered necessary to assess the compressive strength class of recently supplied concrete. The objective of using in-situ Indirect testing plus selected core test data is to minimise the number of cores required, and hence keeping the damage to the structure or element as well as the cost as low as possible.

This document should not be used where the supplier has a low level of quality assurance or no documented procedures. Ideally the supplier should be certified to supply concrete to BS EN 206 and BS 8500-2 to either Quality Scheme for Ready-Mixed Concrete, QSRMC, or BSI Kitemark Scheme for Ready-Mixed Concrete.

2. Planning

A useful first stage is to try and establish from the site and delivery documentation the areas where the concrete deliveries of concern were delivered and placed. The next stage is to divide the total area for investigation into regions and volumes as trying to assess too large an area without sufficient tests will result in an invalid assessment. It will also be useful to complete a visual survey with all parties involved to ensure that any proposed testing locations are both representative and accessible.

In accordance with BS EN 13791, the concrete under investigation shall be divided into regions where each region is for no more than 180 m^3 of concrete. Each region shall be further divided into 1 to 6 volumes, where each volume is no more than around 30 m^3 of concrete.

The division of a region into volumes may be done by simple division into equal volumes. It may be that after consideration of the delivery documentation and site records, including the review of site cube results, it is possible to identify areas of concrete within the region of particular concern where it would be sensible to ensure these are treated as discrete volumes. Where around 30 m^3 of concrete or less is under consideration then the region is a single volume, but where around 30 m^3 of concrete or less is placed over more than one day then each day's concrete is a separate volume.

3. Testing

In accordance with BS EN 13791 indirect testing of site concrete may be either by rebound hammer or Ultrasonic Pulse Velocity (UPV). Rebound hammer tests to be in accordance with BS EN 12504-2 and UPV measurements in accordance with BS EN 12504-4. The apparatus, the test procedure and the expression of test results shall be in accordance with BS EN 12504-2 or BS EN 12504-4 as appropriate. Coring is in accordance with BS EN 12504-1 and the additional requirements set out in BS EN 13791, that is cores shall be ≥ 75 mm diameter and coring not undertaken at a maturity less than 28 day at 20 °C.

4. Assessment

Table 1 sets out the indirect testing locations, core locations and assessment criteria for a region of concrete up to 180 m^3.

Table 1. Summary of indirect testing locations, cores and assessment criteria for a region of concrete[A] up to 180 m^3.

Number of volumes in test region, all < 30 m^3	Minimum total number indirect-test locations for region	Minimum number of 1:1 core results and locations for coring [B]	Assessment criteria[C] Note: Both criteria need to be satisfied for the acceptance of conformity of compressive strength.	
			Mean of core test results at the locations closest to the to the median rebound number or the mean UPV for the test region.	Lowest core result
1[D]	9	**2 cores:** One core at each of the two lowest indirect test values for the test region	—	≥ 0.85($f_{ck,\ spec,\ cube}$ – 4^E)
2	12	**3 cores:** One core at the lowest indirect test value for the test region, and one core at each of the test locations closest to the median rebound number or the mean UPV for the test region.	≥ 0.85($f_{ck,\ spec,\ cube}$ + 1)	
3				
4				
5	20		≥ 0.85($f_{ck,\ spec,\ cube}$ + 2)	
6				

A) Requirements where the concrete producer has product conformity certification.
B) Where the core diameter is ≥75 mm and the length/diameter ratio from 0.90 to 1.10.
C) $f_{ck,\ spec,\ cube}$ = specified characteristic strength in terms of cube strength. '0.85' = EN 1992-1-1 factor that accounts for the difference between the design strength obtained by testing specimens taken from a finished structure or element and the value based on standard test specimens.
D) Only where the 30 m^3 is supplied in one day. Where the concrete is supplied over two or more days then each day's volume shall be considered a different volume.
E) For specified strength C16/20 the constant is reduced to 3, for specified strength C12/15 the constant is reduced to 2, and for specified strength C8/10 the constant is reduced to 1.

Essentially indirect testing is used to minimise the number of cores required, but the assessment is based on the core strengths. Where the results satisfy the assessment criteria then the specified characteristic strength has been supplied.

STANDARDS

BS EN 206	Concrete — Specification, performance, production and conformity
BS EN 1992-1-1	Eurocode 2: Design of concrete structures — Part 1-1: General rules and rules for buildings
BS EN 12504-1	Testing concrete in structures — Part 1: Cored specimens - Taking, examining and testing in compression
BS EN 12504-2	Testing concrete in structures — Part 2: Non-destructive testing - Determination of rebound number
BS EN 12504-4	Testing concrete in structures — Part 4: Determination of ultrasonic pulse velocity
BS EN 13791	Assessment of in-situ compressive strength in structures and precast concrete components
BS 8500-2	Concrete — Complementary British Standard to EN 206. Part 2: Specification for constituent materials and concrete

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