Singapore Standards Council

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Assessment of in-situ compressive strength in structures and precast concrete components – Complementary guidance to that given in SS EN 13791

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Foreword

This Singapore Standard was prepared by the Technical Committee on Building Structure and Sub-structure under the direction of the Building and Construction Standards Committee.

The standard is based on BS 6089:2010 “Assessment of in-situ compressive strength in structures and precast concrete components – Complementary guidance to that given in BS EN 13791”.

Acknowledgement is made to BSI for the use of information from the above publication.

This standard introduces the following:

- This standard is structured as complementary guidance to SS EN 13791;
- Techniques used in the assessment of the strength of structures, but not included in SS EN 13791, are described;
- Flowcharts are included to help users find the appropriate information for their needs.

The deviations from the BS 6089 : 2010 include:

1. Deletion of the recommendations for estimating potential strength (e.g. in Clause 7, Figure 4 and Annex A of BS 6089).
2. Deletion of “Penetration test” (e.g. in Table 4 of BS 6089)
3. Guidance on the effect of transverse reinforcement includes the recommendations of BS EN 12504-1 UK National Annex (NA), SS EN 13791 NA and Concrete Society Technical Report No. 11.
4. Addition of Annex A (informative) “Additional guidelines” on the use of cores of length-diameter ratio of 1:1 for design using SS EN 192-1-1 and Annex B (informative) “Sample test plan”.

This Singapore Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Attention is drawn to the possibility that some of the elements of this Singapore Standard may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

NOTE

1. *Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions.*
2. *An SS or TR is voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether the SS or TR is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document. Enterprise Singapore shall not be liable for any damages whether directly or indirectly suffered by anyone or any organisation as a result of the use of any SS or TR.*
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Introduction

SS EN 13791 contains some methods for assessing the strength of structures, but there are other techniques that are useful for this purpose. As these techniques are not defined in the European standard, it is permitted to describe these techniques in the complementary SS EN 13791 which also permits the method for calculating the in-situ characteristic strength of existing structures about which there is no prior knowledge from core data to be defined in the place of use. Due to the uncertainties associated with investigating unknown structures, the committee wished to define a slightly more conservative system based on established statistical principles. This system is defined in this Singapore Standard.

The publication of SS EN 13791 superseded part of BS 6089:1981. The information that was not superseded is still regarded as being useful and worthy of inclusion in a complementary Singapore Standard to SS EN 13791. In addition, Concrete Society Technical Report (CSTR) 11 [1] is no longer regarded as best practice and is superseded in part by SS EN 13791. In places it also conflicts with SS EN 13791. Consequently, aspects of the CSTR 11 approach have been adopted within the overall system described in this Singapore Standard and the Concrete Society's contribution to the BS 6089:2010 for which this standard is based on is acknowledged.

BS EN 12504-1 describes the method for taking and reporting core tests, which is a building block for SS EN 13791 and this Singapore Standard. BS EN 12504-1 describes how the core strength is measured and reported. To use such data in structural assessment, it is necessary to correct core test data for the length:diameter ratio and transverse reinforcement. The values for such corrections are given in the UK National Annex (NA) to BS EN 12504-1, and there is a recommendation in the UK NA to report both the measured strength and the corrected strength. The Singapore National Annex ZZB to SS EN 13791 provides guidance on the correction for presence of transverse reinforcement in the case of length:diameter ratio up to 1.05. In addition, it is useful and sometimes essential to know the voidage of the cores for the interpretation of the information. The UK NA to BS EN 12504-1 recommends the excess voidage be measured and reported. It ought to be noted that the correction to core strength does not include a correction for voidage as such a correction is inappropriate when determining characteristic in-situ strength.

The assessment of compressive strength in old structures is an area where fixed rules do not apply. The guidance supplied in this Singapore Standard needs to be considered in the light of the specific situation and engineering judgement applied to the specific case.

In general, when dealing with disputes over concrete quality, an assessment with respect to structural adequacy gives the same outcome as an assessment of whether the concrete conforms to its specification. However, there will be a few situations where the concrete will be shown to conform to its specification, yet from a structural viewpoint be inadequate. SS 592 provides no guidance on what should be done in such a situation.

Assessment of in-situ compressive strength in structures and precast concrete components – Complementary guidance to that given in SS EN 13791

1 Scope

This Singapore Standard complements SS EN 13791, which gives methods for determining the characteristic in-situ compressive strength in concrete structures and precast concrete components based on:

a) core testing;

b) rebound hammer, ultrasonic pulse velocity and pull-out force measurements after a relationship with core strength has been determined for the particular concrete under investigation.

This Singapore Standard provides additional guidance on:

- planning an investigation (see Clause 5);
- selection of test methods (see 5.4);
- selection and number of the test locations (see 5.5 and 5.6);
- assessment of individual core results within a group (see 6.1);

In addition, this Singapore Standard provides guidance on the following cases not covered by SS EN 13791:

- assessment of an unknown structure using a margin based on the t-statistic (see 6.2);
- use of indirect methods without correlation to core strength (see 6.3);
- relative testing, i.e. comparison of a volume of concrete under investigation with concrete in similar elements that has been accepted (see 6.4);
- action when the producer has declared nonconformity (see Clause 8).

This Singapore Standard does not provide guidance on:

- the use of cores with a diameter of less than 50 mm or the use of microcores;
- whether a structure has adequate durability;
- the use of in-situ testing as an alternative to conformity testing based on test specimens.

NOTE – For completeness, Figure 1 and Figure 2 identify such a procedure but this Singapore Standard does not attempt to provide any of the necessary detail.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1881-201	Testing concrete – Part 201: Guide to the use of non-destructive methods of test for hardened concrete
SS EN 206-1	Concrete – Part 1: Specification, performance, production and conformity
BS EN 12390 (all parts)	Testing hardened concrete
BS EN 12504-1	Testing concrete in structures – Part 1: Cored specimens – Taking, examining and testing in compression (including National Annex)
BS EN 12504-2	Testing concrete in structures – Part 2: Non-destructive testing – Determination of rebound number
BS EN 12504-3	Testing concrete in structures – Part 3: Determination of pull-out force
BS EN 12504-4	Testing concrete in structures – Part 4: Determination of ultrasonic pulse velocity
SS EN 13791	Assessment of in-situ compressive strength in structures and precast concrete components (including National Annex ZZB)
PD 6687	Background paper to the UK National Annexes to BS EN 1992-1

AINSWORTH, P. R. and HOPKINS, C. J. *Action in the case of nonconformity of concrete structures, C519.* CIRIA, 2000. ISBN 978 0 86017 519 3 [1)]