SS 544-1:2019+A1:2021
BS 8500-1:2015+A1:2016, IDT
(ICS 91.100.30)

SINGAPORE STANDARD

Concrete – Complementary Singapore Standard to SS EN 206

– Part 1 : Method of specifying and guidance for the specifier

Singapore Standards Council

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Published by Enterprise Singapore

ISBN 978-981-48-3576-3

The content of this Singapore Standard was approved on 18 July 2019 by the Building and Construction Standards Committee (BCSC) under the purview of the Singapore Standards Council.

First published, 2009
First revision, 2014
Second revision, 2019

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National Foreword

This Singapore Standard was prepared by the Technical Committee on Building Structures and Substructures under the purview of BCSC.

This standard is a revision of SS 544-1:2009. It is an identical adoption of BS 8500-1:2015+A1:2016 Complementary British Standard to BS EN 206-1, Part 1: Method of specifying and guidance for the specifier' and is implemented with the permission of the British Standards Limited.

SS 544 – 'Concrete – Complementary Singapore Standard to SS EN 206' comprises two parts:

- Part 1: Method of specifying and guidance for the specifier;
- Part 2: Specification for constituent materials and concrete.

This revision introduces the following principal changes:

- Changes necessary to align with the publication of SS EN 206:2014;
- Changes resulting from new or revised European Standards published since 2006;
- Alignment with conformity assessment and accreditation policy in Singapore;
- Changes made to align the recommendations for seawater exposure with that of the British Standard for maritime structures: BS 6349-1-4;
- Introduction of designated cement-bound concrete;
- Modification of requirements for concrete to resist freezing and thawing;
- Corrections and minor clarifications;
- Requirements and guidance for consistence retention testing have been added to Annex B; and
- All references have been updated.

NOTE – A new Annex (Annex D) has also been added to SS 544-2:2019, which sets out where to find the SS 544 provisions that cover SS EN 206 requirements that defer to provisions in the place of use.

The changes are predominantly concerned with the increased range of cementitious materials covered. These include: natural pozzolana, natural calcined pozzolana or high reactivity natural calcined pozzolana as an addition, Portland-pozzolana and pozzolanic cements, as well as a range of ternary cements which include up to 20% limestone fines. The recommendations for the use of natural, natural calcined and high reactivity natural calcined pozzolana, as part of cement or combination, are based on the assumption that their performance in concrete is similar to fly ash. The recommendations for ternary cements, which include up to 20% limestone fines, are for applications where their use is considered safe and durable. The option to use durability modelling or an equivalent durability procedure is clarified. Minor editorial changes are not tagged, such as the change of nomenclature from N/mm2 to MPa for stress.

As amended, May 2021

SS 544 contains additional Singapore provisions to be used in conjunction with SS EN 206. Together they form a complete package for the specification, production and conformity of fresh concrete.

The following information has been included in the standard:

- Under Introduction, (a) Designated concretes, paragraph 2 has been replaced by the local practice.

- A new paragraph on the performance approach to specifying self-compacting concrete has been inserted under the Introduction.

- An additional sentence has been added under A.3, paragraph 6 to indicate that the nominal cover has been given based on the recommendations in SS EN 1992-1-1 and the National Annex to SS EN 1992-1-1.

- An additional NOTE has been added under A.4.1 to refer users to the National Foreword of SS 544 for additional guidance in Singapore.

The following guidelines are to guide local users:

1. Clause 4.2 – Designated concretes and Clause 4.5 Standardised prescribed concretes

   Designated concretes and standardised prescribed concretes are derived based on UK experience and materials. Local users are advised to make appropriate judgment on the relevance / suitability of their use in the specific environmental conditions (see Introduction, Clause 6 and Clause 9 of SS 544-2 for constituent materials and concrete).

2. Clauses 4.3.3 (f) and 4.4.3 (d) – The temperature of fresh concrete should not exceed 38 ^{o}C.

3. Clause A.2 – Exposure classes related to environmental conditions

   In order to cater to the higher ambient temperatures in Singapore compared to UK, the recommendation is to consider the required concrete for at least one class higher than that based on exposure conditions in accordance with the requirements for UK exposure conditions (refer to Tables A.3 to A.5). The specifier should take into consideration the nature of the element, intended working life, its importance and the cost of maintenance and repair to select the same or higher performance concrete. Different elements in the same structure may be specified with different concrete to optimise cost-effectiveness.

   NOTE – Clause A.3 'Cover to reinforcement' – United Kingdom environment is the basis for the recommendations, its adequacy for Singapore has to be considered by users. In addition to the effect of higher ambient temperatures in Singapore compared to UK, protection for steel reinforcement is also dependent on both the cover thickness and the in-situ quality of the cover concrete. Adequate curing is necessary, particularly when supplementary cementitious materials are used to partially replace Portland cement.

4. Clause A.4.3 Concrete properties and limiting values to resist freeze-thaw attack

   This clause is not normally needed for Singapore but may be necessary for special applications such as cold rooms or skating rinks.

5. Clause A.9.2 Work in cold weather

   This clause is not relevant for Singapore.

6. Clause A.9.3 Work in hot weather

   The maximum temperature of 38 ^{o}C is recommended unless any other value is specified, or permitted by specifier.

7. Clause A.10 Conformity and identity testing

Use of 100 mm cubes for conformity (using the same strength criteria for 150 mm cubes, see SS 544-2:2019 12.2) is recommended. Based on limited results, it is generally expected that the average of 100 mm cubes may be around 4 % higher in compressive strength than 150 mm cubes but with a higher standard deviation by about 1 to 3 N/mm^2. Hence, the assumed normal distribution of cube strengths for each of the two sizes has a large overlap with each other. With a higher standard deviation for the 100 mm cubes, the slightly higher expected mean may not always lead to a higher characteristic value, and may be equal or even lower than that for the 150 mm cubes. The adoption of 100 mm cubes is more environmentally friendly and supports industry efforts to promote construction sustainability

It has been assumed in the preparation of this Singapore Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

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. Where SSs are deemed to be stable, i.e. no foreseeable changes in them, they will be classified as "mature standards". Mature standards will not be subject to further review, unless there are requests to review such standards.*

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 and the Singapore Standards Council 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. Although care has been taken to draft this standard, users are also advised to ensure that they apply the information after due diligence.*

3. *Compliance with a SS or TR does not exempt users from any legal obligations.*

Concrete – Complementary Singapore Standard to SS EN 206 – Part 1: Method of specifying and guidance for the specifier

0 Introduction

The specifier is offered five approaches to the specification of concrete.

(a) Designated concretes

For many common applications, the simplest approach is to specify a designated concrete. Designated concretes were developed to make the specification of designed concretes simpler, complete and more reliable. While they do not cover every application nor do they permit the use of every potential concreting material, they are suitable for a wide range of housing, structural and other construction applications.

An essential part of the designated concrete concept is the requirement for the producer to hold current product conformity certification (see 3.1.14) and therefore designated concretes are only applicable where third-party certification is selected as the option in specifying the concrete. Where the option selected is not to use a certified concrete, the method of designation/specification given in b), c) or d) below is used.

It is stressed that the reference to third-party certification does not make such a method of specification obligatory: it has been included with the support of industry bodies wishing to maintain the progress which has been achieved in quality levels as a result of such certification.

The environments to which the concrete is to be exposed are identified from A.2. Guidance on the selection of designated concrete is given in A.4 and the specification is drafted in accordance with 4.2.

(b) Designed concretes

Designed concretes are suitable for almost all applications. They may be used as an alternative to designated concrete and should be used where the requirements are outside of those covered by designated concretes, e.g.:

- where special cements or combinations are required, e.g. low heat of hydration;
- where the concrete is to be exposed to one of the chloride (XD) or sea water (XS) exposure classes;
- where lightweight or heavyweight concrete is required;
- where a strength class is required other than those covered by designated concrete;
- where strength is a requirement for the concrete and product conformity certification (3.1.14) is not required.

NOTE – Product conformity certification (see 3.1.14) is recommended for all concrete, including designed concrete, although it is not obligatory unless required by Regulation.

The environments to which the concrete is to be exposed are identified from *A.2.* Using the intended working life and the minimum cover to reinforcement, the limiting values of composition are determined for each of the identified exposure classes using the guidance in *A.4.* The requirements for the concrete are selected from this composite of limiting values plus structural and fire considerations, and the specification is then drafted in accordance with 4.3.

(c) Prescribed concretes

This approach allows the specifier to prescribe the exact composition and constituents of the concrete. It is not permitted to include requirements on concrete strength, and so this option has only limited applicability.

Where a prescribed concrete is specified, the specifier is responsible for any initial testing to determine that the specified proportions achieve the intended performance in the fresh and hardened states with an adequate margin (see SS EN 206:2014, 6.3). According to SS EN 206, the specifier is also responsible for ensuring that the specified proportions do not result in damaging alkali-silica reaction (ASR), but see *A.8.1* for an alternative approach.

In general, it is better to specify using one of the performance options (designated or designed concrete), but there are a few situations where the prescribed concrete method of specification is appropriate. For example, with exposed aggregate finishes, uniformity of appearance is a key requirement. Having done trial mixes to confirm that the finished surface is as required and the mix satisfies the other required properties, e.g. strength, maximum w/c ratio, with an adequate margin, the concrete may then be specified as a prescribed concrete using the sources and proportions of constituent materials used in the approved trial mix.

The specification is drafted in accordance with 4.4.

(d) Standardised prescribed concretes

Standardised prescribed concretes are applicable for housing and similar construction where concrete is site-batched on a small site or obtained from a ready-mixed concrete producer who does not have product conformity certification (3.1.14). Guidance on the selection of standardised prescribed concrete is given in A.4.5 and the specification is drafted in accordance with 4.5.

Standardised prescribed concrete may be used as an alternative to the GEN series of designated concretes. As the concrete producer is unlikely to be known at the time of specification, the best approach in these situations is to specify a suitable designated concrete and the equivalent standardised prescribed concrete as alternatives.

(e) Proprietary concretes

This approach is appropriate where it is required that the concrete achieves a specific performance, using defined test methods. The proprietary concrete is selected in consultation with the concrete producer and the specification is drafted in accordance with 4.6.

NOTE – This method of specification might not be suitable for initial use in public procurement contracts if the specification, in effect, determines the concrete producer. BSI/Enterprise Singapore has not substantiated any claimed performance made for proprietary concrete by any producer.

The producer is not required to disclose full details of the mix constituents or composition to the specifier. Where the concrete is produced under product conformity certification (see 3.1.14), the producer is required to substantiate to their third-party certification body that their proprietary concrete satisfies any performance requirements and limiting values that are specified or declared. Where the concrete is not under product conformity certification (see 3.1.14), the producer is required to confirm that any performance requirements and limiting values that are specified or declared were satisfied and, on request, supply the relevant test data.

A performance approach to specifying self-compacting concrete is given in *The European Guidelines for self-compacting concrete - specification, production and use* [2]. This uses the proprietary method of specification and is written in a form that complements SS EN 206. In this case, the compressive strength class and limiting values are specified as if a designed concrete was being specified, but the properties of the fresh concrete are specified from the classes given in the *Guidelines.*

Within each approach to drafting the specification, there are a number of instances in which the specifier selects from the various options given in this part of SS 544.

As amended, May 2021

The Foreword to SS EN 206 sets out the context in which SS EN 206 operates in the context of European standards. As SS 544 is Singapore complementary standard to SS EN 206, the context in which SS 544 operates is the same when SS 544 is used within a suite of Singapore Standards.

1 Scope

This part of SS 544 describes methods of specifying concrete and gives guidance for the specifier.

Annex A of this Singapore Standard provides guidance on the concrete quality to specify for selected exposure classes, intended working life and nominal cover to normal reinforcement. It does not give guidance on stainless steel and non-metallic reinforcement. Guidance on nominal cover to reinforcement for structural and fire consideration is available in other publications, e.g. structural design codes of practice.

This part of SS 544 complements SS EN 206. It provides Singapore national provisions where required or permitted by SS EN 206. It also covers materials, methods of testing and procedures that are outside the scope of SS EN 206, but within national experience.

2 Normative references

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

ASTM C173	Standard test method for air content of freshly mixed concrete by the volumetric method
BS EN 12350-1	Testing fresh concrete – Part 1: Sampling
BS EN 12350-2	Testing fresh concrete – Part 2: Slump test
BS EN 12350-5	Testing fresh concrete – Part 5: Flow table test
BS EN 12350-6	Testing fresh concrete – Part 6: Density
BS EN 12350-7	Testing fresh concrete – Part 7: Air content – Pressure methods
BS EN 12350-8	Testing fresh concrete – Part 8: Self-compacting concrete – Slump-flow test
BS EN 12390-7	Testing hardened concrete – Part 7: Density of hardened concrete
SS 544-2:2019	Concrete – Complementary Singapore Standard to SS EN 206 – Part 2: Specification for constituent materials and concrete
SS EN 206:2014	Concrete – Part 1: Specification, performance, production and conformity