Self-compacting Concrete

Introduction

Self-compacting concrete (SCC) is a high performance concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the similar engineering properties and durability as traditional vibrated concrete.

Clearly the market potential for SCC in New Zealand is significant particularly in conjunction with the role of structural reinforced concrete in seismic areas.

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of SCC ensures a high level of homogeneity, no concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier demoulding and faster use of elements and structures.

The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration.

The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction.

All aspects of SCC technology have been well researched. SCC technology has achieved significant project solutions in practice. Examples of it can be found in a numerous publications around the world and in New Zealand. SCC technology is supported by major international industry associations and institutions such as RILEM, FIB, ACI and others. One of the most comprehensive publications that summarises information on specification, production and use is the European Guidelines for Self-compacting Concrete.

High Quality Surface Finish

"The European Guidelines for Self-compacting Concrete"

(This document can be downloaded from www.efca.info from the Publication Section of their website). It is recommended that this document be used as the primary source of information. This bulletin offers comment on the New Zealand equivalent Standard references where available.

Scope of European Guidelines	New Zealand Comments on Guidelines
The scope of the Guidelines is indicated by the extracts from Contents Schedule below:	
5. Engineering Properties 5.1 General 5.2 Compressive Strength 5.3 Tensile Strength 5.4 Static modules of elasticity 5.5 Creep 5.6 Shrinkage 5.7 Coefficient of Thermal Expansion 5.8 Bond to reinforcement, prestressing a wire 5.9 Shear force capacity 5.10 Fire Resistance 5.11 Durability 5.12 References	**5. Engineering Properties** Broadly SCC follows the same influences of w/c, paste volume, aggregate selection etc of traditional concrete. NZS 3101 Clause 5.2 Properties of Concrete confirms this with the exception of recommending that the coefficient of thermal expansion be reduced by 15%.
6. Specifying SCC for Ready Mixed Concrete and Site Mixed Concrete	**6. Specifying SCC for Ready Mixed Concrete or Site Mixed Concrete**
6.1 General	**6.1 General** New test procedures are now included in NZS 3112.1 for determining flow ability and rate of flow – slump flow and T500 slump flow test.
6.2 Specification	**6.2 Specification** Use the proprietary method of specification which means that the concrete producer assures the performance subject to good practice in placing, compacting and curing. SCC should be regarded as an alternative method of construction rather than an alternative material. Hence the contractor can chose SCC in favour of using vibrated concrete.
6.2.1	6.2.1 Use the latest revision NZS 3101 to determine the basic requirements of compressive strength, durability, aggregate size and chloride. From Euro-document advice, choose the appropriate slump flow classes.
6.2.2	6.2.2 Consider as appropriate to project. T500 value advice is in Euro-document.
6.3 Requirements of Fresh State	**6.3 Requirements for Fresh State** Contractor/producer will choose the intended properties for fresh SCC from this section. This will include the filling and flow characteristics and on-site quality control using the spread and slump flow tests
6.4 Consistence Classification	**6.4 Consistence Classification** Contractor/producer will use Euro-document to complete the SCC specifications as related to the particular application. See Figure 1 and Annex A.

6.4.1 Slump-flow	There are 3 categories SF1 (550–650 mm), SF2 (660–750 mm) and SF3 (760–850 mm). Selection depends on the application.
6.4.2 Viscosity	Generally use the T500 time for a guide on viscosity.
6.4.3 Passing Ability	Generally only needs to be considered for very special congestion of reinforcement.
6.4.4 Segregation resistance	General applications within the parameters of SF1, 2 and 3 need not consider this.
6.5 Specification Examples	See **Diagram 1**. Typical applications in New Zealand shown on Pages 4, 5 and 6 of this Bulletin.

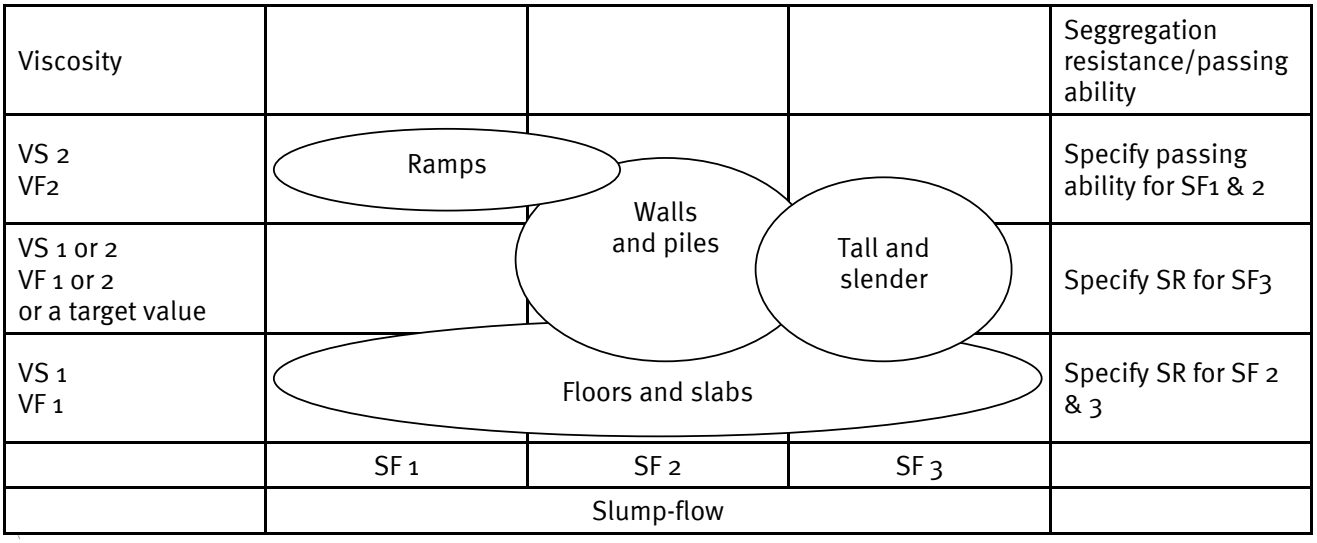

Diagram 1: Properties of SCC for various types of application based on Walraven, 2003 from Euro Guidelines.

7. Constituent Materials **8. Mix Composition** **9. Production for Ready Mixed and Site Mixed Concrete**	These sections contain advice that is all within the **operations of NZRMCA audited plants working to NZS 3109/NZS 3104.** Decisions on material, mix design and production will be made by the plant supplying SCC, which in terms of NZS 3109 is a Special Concrete.
10. Site Requirements and Preparation **11. Placing and Finishing**	**These sections contain advice which is consistent with NZS 3109** but emphasises the need for adequate formwork to resist pressures and describes filling by pumping from the bottom of vertical formwork.
12. Precast Concrete Products	
13. Appearance and Surface Finish	
Annex A: Specification of SCC	The normative references for NZ would be NZS 3109 Concrete Construction and NZS 3104 Specification for Concrete Construction. For testing for spread and slump flow NZS 3112 Part 1 Testing for Fresh Concrete.
Annex B: Test Methods for SCC	
Annex C: Improving the Finish of SCC	

New Zealand Examples

General

Employing SCC in practice may necessitate changes in construction approach since a previous limiting factor of the placing, compaction/vibration time has been significant.

This essentially passes this limit of rate of placing to the pumping equipment which in turn relates to the rate of supply of concrete that can be organised.

While any major wall requires significant attention to formwork design and construction, clearly raising the rate of pour maximises pressures in the formwork.

It is therefore prudent to design formwork for full hydrostatic pressure although it may not develop in elements where the rate of rise is modest.

It is important to ensure that formwork is both leak proof and robust enough to withstand the higher demands made on it – see **Photo 1**.

Surface Finish

As a follow on from the general consideration, fast and continuous placement of concrete leads to a better surface finish.

High quality surface finishes are achievable with care and attention to formwork quality, and the selection and appropriate application of the correct mould release agent – see **Photo 2**.

When pumping from the top of the formwork the tremie technique has been shown to give the highest quality finish – see **Photo 3**.

Pumping SCC from the bottom is shown in another example of wall construction also achieving a top quality finish – see **Photo 4**.

Intricate special features can also be formed as is shown in **Photo 5**.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Special Projects

SCC can be used to replace conventional concrete in difficult applications. In the case illustrated here, the narrow in-situ splicing joint between precast concrete reservoir panels has been more easily completed using a bottom pumping of SCC to fill the joint – see **Photo 6** and **Photo 7**.

Photo 6

Photo 7

The finished joint is illustrated in **Photo 8**, showing the complete and uniform state of the infill joint.

Summary

While these projects were selected to illustrate examples of specific use of Self-compacting concrete, the method itself is essentially available for use as a replacement of most conventional concrete applications.

The SCC technology offers opportunities to substantially improve current concrete construction practices, which in turn creates considerable time and labour savings.

Acknowledgements are made to:

- Allied Concrete for Photo 1.
- W Stevenson & Sons for Photos 2, 3 and 4.
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Photo 8

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