Self-Compacting Concrete: New Zealand Experience 2000 – 2003

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ABSTRACT

This paper is the combined experience of Stevensons Concrete, Allied Concrete, and Firth Industries in developing and supplying Self-Compacting Concrete (SCC) to commercial and residential markets during 2000 - 2003. Since SCC was introduced in New Zealand in early 2000, it was used in a variety of applications and different casting techniques were tested. This period was also a great learning curve for both suppliers and users of SCC to identify and extract the best benefits out of the progressive concrete technology. SCC technology offers a number of obvious and potential benefits for all interested parties involved in the building industry: for suppliers (SCC technology forces to improve the production quality control), for design engineers (offers much more flexibility to design cost effective structures), for architects (offers an excellent tool to convert their visions into reality), constructors and owners (overall cost effectiveness). A number of case studies with the focus on reasoning of using SCC and benefits obtained are presented in the paper. The paper also gives an overview of the main properties and benefits of SCC.

1. INTRODUCTION

The purpose of this paper is to encourage the use of self-compacting concrete technology in general construction and to help realize the potential economics and environmental benefits of this technology.

Self-Compacting Concrete (SCC) is widely recognized as a fundamental revolution in concrete technology. The SCC offers solutions to many construction and design problems, such as quality, productivity and economy, environment, design flexibility, and so on. In order to appreciate and recognize all the benefits and values SCC can provide, it should be seen as a technology, not as a prescribed set of test values or mix proportions [1, p. 5]. To extract the values from this technology and to be able to quantify them, more knowledge and willingness of all actors to view SCC as a technology are required.

The history of development of self-compacting concrete goes back to a more than decade when a self-compacting concrete prototype was developed for the first time in the summer of 1988 in Japan by professor H. Okamura. This was the result of basic research on fluidity and segregation resistance of fresh concrete. Lack of skilled workers and the reduction in the quality of construction work were the major influencing factors for the development. One of the solutions to achieving quality concrete structures independent of the quality of the workmanship was the employment of self-compacting concrete.

After a few initial publications and presentations at international events like CANMET & ACI International Conference in Istanbul and ACI Workshop in Bangkok in early 90’s, the concept of self-compacting concrete became one of the greatest interests of researches and engineers around the world. Intensive research started in Sweden and Netherlands in mid 90’s. The first International Workshop on Self-Compacting Concrete was held in August 1998 in Kohi, Japan. Researchers from around the world shared their experience in research, development, and applications of SCC [2].

By the mid 90’s leading concrete research institutions in Europe (Swedish Cement and Concrete Research Institute, University of Paisley, UK, Delft University of Technology, The Netherlands, Icelandic Building Research Institute), as well as in Canada (University of Sherbrooke) and USA (Northwestern University), set out their R&D programs to better understand rheological behavior of SCC, its design principles and properties at both fresh and hardened states.

RILEM (The International union of testing and Research Laboratories for Materials and Structures) structured the First International Symposium on Self-Compacting Concrete. It was held in September 1999 in Stockholm (Sweden). The Second International Symposium on Self-Compacting Concrete was held in Tokyo in October 2001. The Third International Symposium on Self-Compacting Concrete was in August 2003, in Iceland, which was also organized under
RILEM’s umbrella. The First North American Conference On The Design And Use Of Self-Consolidating Concrete was hosted by the Center of Advanced Cement-Based Materials, Illinois, USA in November 2002. All these events raised large-scale interest of researchers, engineers, and designers all around the world to the prosperous technology. Results of these researches and investigations, successful applications, and the prospects of the new technology were presented and discussed at these events and sowed a great deal of confidence and belief.

In 1998 the European Union funded a large research project to investigate the practicalities of SCC, with the main goal “to develop a new vibration-free production system to lower the overall cost of in-situ cast concrete construction” [3]. This project was successfully completed in 2000 and it confirmed the possibility of using SCC in practical civil engineering and building construction and that significant commercial benefits could be obtained. It was also realised that the progress is slowed down by the absence of agreed fresh SCC testing methods. The European Union agreed to fund another project with the aim to develop and standardise such test methods. This project started in 2001. Twelve partners will carry out the research to completion in 2004.

In addition to the achievements and progress of these two international research projects, a huge amount of research and development is occurring at local levels. The major points of such researches can be summarised as follows:

- rheology of SCC,
- constituent materials
- formwork and form pressure,
- mechanical properties and durability,
- other properties of SCC and means to control them,
- casting techniques, etc.

Many countries and international industry organizations have published the SCC guidelines for designers, producers and users of self-compacting concrete. Below is the short list of some most known publications:

- Recommendation for Self-Compacting Concrete, Japan Society of Civil Engineers, August 1999;
- Self-compacting concrete. Recommendations for use. Concrete Report No. 9(E), Swedish Concrete Association, 2002;

2. WHAT DO WE KNOW ABOUT SELF-COMPACTING CONCRETE?

RHEOLOGY

The basic property influencing the fresh concrete performance in placing and compaction is its rheological behaviour. Thus the knowledge of the rheology of fresh concrete is vital.

Fresh concrete can be seen as a fluid, providing that a certain degree of flow can be achieved and that concrete maintains its homogeneity. Most concretes with a slump of at least 90 mm would fall under this. Flow of a fluid can be described by the “shear stress – shear rate” concept. Concrete as a fluid is most often assumed to behave like a Bingham fluid and its flow is defined by two parameters: yield stress and plastic viscosity (Fig. 1).

The Bingham equation is:

$$\tau = \tau_0 + \mu \dot{\gamma}$$

where $\tau$ – the shear stress applied to a material,  
$\tau_0$ – yield stress,  
$\mu$ – plastic viscosity,  
$\dot{\gamma}$ – shear strain rate (strain gradient)

The point at which concrete flows is the yield stress and the slope of the curve above this stress is the plastic viscosity.

For normal concrete a minimum force (yield stress) is required to bring concrete to flow. Vibration is normally such a force. The main influencing mechanisms are inter-particle friction and free water content [2, p 62].

In case of SCC, yield stress $\tau_0 \to 0$. SCC is approaching Newtonian fluid. It means that SCC does not require any external forces to bring it to flow.

The following are rheological characteristics of normal concrete and SCC:
Normal Concrete:
- high yield stress, and
- moderate plastic viscosity.

Self-compacting concrete:
- low yield stress, and
- increased plastic viscosity

MIX DESIGN CONCEPT AND WORKABILITY

SCC is distinguished from normal concrete only by its rheological behaviour, so the major focus of the mix design is to achieve desired fresh self-compacting concrete properties.

Rheological properties of SCC depend on the material used and, most importantly, materials proportioning. There are number of SCC mix design approaches, but all of them are consistent with the following steps:

- construction criteria is identified – clear spacing, strength, durability;
- analysis of the blocking criteria – determination of maximum size of coarse aggregate and its content;
- formulation of the mortar composition – water-binder ratio, air-pore structure, mineral and chemical admixtures;
- formulation of the final SCC mix proportion – workability, non-blocking and stability tests, adjustments if necessary.

Workability of concrete is a very broad term, which is related to consistency, placeability, pumpability and stability. The most common way to characterise workability of normal concrete is slump value.

By definition, SCC is a high-performance concrete that flows into place and around obstructions under its own weight without segregation and flow blockage. Hence the major workability characteristics of self-compacting concrete are as the following:

- filling ability – SCC flows into all the spaces within the framework under its own weight,
- passing ability – SCC flows through tight openings under its own weight, and
- resistance to segregation – SCC meets the requirements of both above characteristics while its original composition remains uniform.

TESTING OF SCC PROPERTIES

Workability parameters of SCC have to be adequately evaluated by using some testing methods. So far a number of methodologies and testing equipment have been developed to evaluate the three major characteristics of SCC.

The simplest test to assess filling ability (flowability) of SCC is Slump Flow or Flow Spread test. (This test has been used to verify flowability of grouts and is well described in NZS 3101, Part 3). Depending on the construction criteria, the average diameter of the spread should be between 600 and 750 mm (Fig. 2).

The passing ability of SCC can be assessed by L-box test (Fig. 3) or some other methods, e.g. U-box test, Filling Vessel, etc.). An acceptance criterion for such test is that SCC should flow through obstacles without blocking. The clear space between re-bars can be adjusted according to construction and design criteria.

Resistance to segregation of SCC is the most difficult property to measure and quantify. Up until now there are no test methods developed to reliably quantify the segregation resistance of SCC. On the other hand there are no widely accepted test methods to measure, or even reliably assess, the stability of normal concrete under vibration. By definition, segregation of concrete is a separation of one or more constituents of the
concrete and their concentration in one part of the mix with the resulting lack of it in the remaining part [4]. For normal concrete slump test results can indicate poor stability when, for example, shear slumps are observed. The result of slump flow test performed to assess the flowability of SCC is successfully used to visually assess the stability of SCC.

A number of methods were developed around the world and described in number of publications so far in order to apply some measurements on assessing segregation [5, 6], but today’s experience and practicality indicate that slump-flow test has been successfully used for SCC segregation assessment (e.g. MBT in USA has developed a Visual Stability Index to define SCC’s stability; it has a gradation from 0 (very stable) to 3 (segregated) depending on the slump-flow shape and appearance).

CONSTITUENT MATERIALS

Self-compacting concrete can be made with commonly used aggregates, both natural (rounded) and crushed, and sands. Although quality characteristics of aggregates are of a great importance, the consistency of properties of aggregates is even more critical.

No limitations on the commonly available cements have been identified. Mineral fillers like fly ash, powder limestone, silica fume and other are widely used to achieve desired workability properties of SCC and enhance its durability characteristics. Some fillers may have some undesired affects on properties of SCC; hence the type of fillers should be considered carefully.

As far as superplasticisers are concerned, the new generation polycarboxilated ethers are recommended as most suitable for SCC.

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF HARDENED SCC

The microstructure of SCC is improved due to the avoidance of vibration and general composition of SCC [7, 8]. This is especially evident in the improvement of the tightness of the transition zones between aggregate and paste (Fig.4 and 5). The light area around aggregate particles of vibrated concrete (Fig.4) is likely to be pore water localised around particles due to induced vibration. Such phenomena is not present in SCC microstructure (Fig.5).

So far combined experience indicates that the main mechanical properties (strength, permeability, drying shrinkage, etc.) seem to be enhanced for SCC compared with ordinary concrete of the same water-to-cement ratio [3, 5, 7, 8]. High strength (70-80MPa and higher) can be easily achieved with SCC. Strength of drilled cores have been noted to be higher then those of normal concrete [7, p.517 – 526].

PRODUCTION, TRANSPORTATION AND CASTING

“SCC is a more complicated product than normal concrete requiring more knowledge and sharper quality assurance, both adding to the cost and to the value of the product” [7, p. 6].

SCC can be produced in any industrial type of mixers including mixers mounted onto trucks. More efficient mixers produce more consistent SCC. As it was mentioned before, materials used to produce normal high quality and economical concretes can be successfully used to produce quality SCC. Extra attention and care, though, should be placed on moisture content of the aggregates. Self-compacting concrete is generally more susceptible to fluctuation of water content than normal concrete. In order to reduce the adverse effect of such fluctuation, the surface moisture of materials should be measured by an adequate method and its correction should be made accurately and promptly, prior to batching SCC.

Batching order of materials, batch size and mixing time should be established according to the test results and field experience.

The production of SCC requires more thorough control compared with production of normal concrete. At the production plant the properties of SCC should be checked with respect to at least slump-flow and stability. The acceptance criteria and testing frequency should be agreed between producer and the customer.

SCC can be delivered to job sites in truck mixers. Due to high flowability of SCC the maximum load should be reduced to 80-90% of full loading capacity of the truck mixer.
Casting is the essential and inseparable part of the SCC technology if full benefits are to be obtained. SCC can be discharged straight from the truck into the mould. It can also be skipped. But the most efficient and effective way to place SCC is by pumping SCC into the mould. SCC does not need to be modified for pumping. The type of the concrete pump mainly depends on aggregate size used for SCC and construction requirements. It was reported that pump pressure is substantially reduced when SCC is pumped [3]. SCC can be pumped either to the top of the mould, or from the bottom to the top of the mould.

A special consideration should apply to the formwork design. In general, the formwork should be design to bear the lateral pressure of concrete. A number of publications are reporting that form pressure generated by self-compacting concrete is 70-90% of hydrostatic mainly depending on casting rate, casting method, and the SCC mix design [1, p. 295-302; 7, p. 585-594].

ENVIRONMENT, HEALTH AND SAFETY

Reduction of vibration noise has a substantial impact on on-site working environment. No disturbing noise means pleasant environment for both, the workers and the neighbourhood. Compliance with the noise regulations is easier, which is especially important in urban areas. The most important aspects of an improved working environment are the elimination of blood circulation disturbance due to handled vibrators and the strongly reduced noise level. Also much less physical effort is required to move concrete around the formwork. Safety is increased due to elimination of cables, vibrators, transformers on the workplace and possibility of better communication between workers [7, p. 1-12].

BENEFITS

- **Quality of structures is improved.** Mechanical properties are improved in general due to the fact that absence of vibration tightens the microstructure.

- **Substantial environmental improvement.** Absence of noise and vibration improves the general health and safety on construction site and improve working and surrounding environments.

- **Design and construction flexibility.** Both the plastic and the hardened properties work to the advantage to the designer. SCC can better fill areas of congested steel or hard-to-reach places giving greater confidence of the structural integrity. In combination of high strength, SCC offers many more options to design more aesthetically attractive, more economical 'smart' structures.

- **Potential for industrialisation and automation of construction process.** SCC technology opens the doors to automation and industrialisation of casting processes, especially for precasters.

- **Cost effectiveness.** From the combined experience available so far, it was proven that if properly designed and implemented, SCC technology is very cost effective, considering that all obvious and hidden benefits are obtained.

SCC IS A VALUE ADDED TECHNOLOGY

A successful implementation of any new technology can only be achieved if it delivers a better value product to the end user at a lower price. Started as a quality improvement product, SCC technology has developed into a value added product in many applications around the world.

The price for self-compacting concrete is generally higher than it would be for normal concrete for the same application, but increased productivity due to reduction of labour cost per unit volume and reduction of the construction time give additional savings. When some other potential savings, such as: (a) reduction of tear and wear of formwork, (b) fastening of individual re-bars can be less rigid, (c) sick leave costs are lower, (d) reduced power costs, etc. are added, it becomes obvious that in the long run, SCC technology is very attractive as a cost effective and value added product.

Of course to enjoy the full benefit the SCC technology can offer, an extra knowledge, willingness to learn and new way of thinking are required.

3. HOW WE USE WHAT WE KNOW

Up until now the main driving force behind the introduction of self-compacting concrete in New Zealand was the enthusiasm of a few keen people predominantly from the ready-mixed industry. Their main interest in SCC technology was a great desire to improve the quality of concrete structures, to improve the working environment, to offer new opportunities to designers and architects and ease to constructors.
All our experience and findings are pretty much in line with what we’ve learned so far about SCC. The major New Zealand concrete ready-mixed companies started their experiments with SCC separately to each other but in approximately the same time, early 2000. We were experimenting with different coarse aggregates and sands, cements and fillers, and admixtures. The development programs have in general included the following stages:

- material analyses,
- laboratory trials to achieve desired properties of SCCs,
- full-scale trials to verify laboratory results,
- real applications to validate consistency of SCC properties.

Our very first finding was that general materials, like coarse aggregates, sands, cements, fly ash, silica fume, microsilica that are used for normal concretes can be successfully used to produce high quality SCCs. SCC were developed and supplied to the variety of applications using crushed and rounded coarse aggregates, river and sea sands, both Golden Bay and Holcim cements, Huntly fly ash, silica fume, Microsilica, limestone powders, polycarboxilated superplasticisers supplied by W R Grace, MBT, and Sika. So, there is no limitation in materials available in New Zealand to produce high quality self-compacting concretes. Ready-mixed companies though might use the different mix design techniques and SCC development methodologies. The final result depends on the SCC designer’s knowledge, experience, and full understanding of the construction requirements.

Development of SCC requires time, so in some remote areas or for some specific applications SCC may not be available overnight.

What should be understood is that normal concrete cannot be converted into self-compacting concrete by just adding more water or superplasticiser into the mix. Someone might experience some success by doing so, but most of the time it would be either just a matter of good luck, or an illusion. Regardless of how concrete was developed, the self-compactability must be verified. According to JSCE Recommendations for Self-Compacting Concrete [10], the self-compactability is achieved when three major properties, i.e. filling ability, passing ability and stability are verified.

The rheological properties of SCC depend on the materials and proportioning. It follows that the materials and batching needs to be consistent and accurate during actual production. A modern well run readymix batching plant will have no trouble meeting the batching requirements. Some inconsistency in the materials can be accommodated by a suitably robust and forgiving mix design, but good control over the material properties will allow the mix design to be optimised for its purpose.

One material that requires extra effort to control is the water, or rather the quantity of water. Water contained within the aggregates as free water can significantly change water/binder ratio and affect the rheological properties of the SCC. Regular monitoring of aggregate moisture content is required, and the added water adjusted to suit.

As SCC mixes contain a large quantity of cement and fine fillers, the mixing required for full dispersion can be prolonged. High shear mixers give more rapid dispersion so allowing more rapid production, however truck bowl mixing has proved satisfactory.

The superplasticiser is most commonly added at the plant after initial mixing. When the job is close to the plant, the full amount can be added and the SCC properties checked at the plant prior to dispatch. For jobs further from the plant, some on-site control of the SCC is required, so 60-80% of the superplasticiser is added at the plant with the remainder used to adjust the SCC properties on the job. However there have been times when adding the full amount at the plant proved to be the very successful.

One thing that should be remembered, though, is that self-compacting concrete does not allow for short cuts. The common procedures to correct workability of normal concrete at the batching plant, e.g. ‘wetting’ with extra added water and ‘drying’ with small quantity of the ‘dry’ mix, cannot be used to correct workability of SCC. Some other techniques are recommended to control the desired properties of fresh SCC [9].

Whether placed directly from the chute or pumped into position, there are significant changes to the normal placing procedures. Some are obvious and others more subtle.

The most obvious is no energy other than the flow energy within the concrete is required for it to fill and consolidate. It is important to note that flow is
required for full filling and consolidation and this means some thought needs to go into ensuring the SCC can develop a flow pattern or circulation. For a cast in-situ wall this can simply mean filling from one or two points and allowing the SCC to flow along the wall, rather than moving the filling point along the whole length of the wall as would be done with normal concrete. For a congested beam column joint, it is often better to allow the SCC to flow through the joint rather than place it directly into it.

SCC is easily pumped with some prodigious heights and distances being achieved overseas. The low yield stress and higher plastic viscosity results in low pump pressures at low pumping rates, but pump pressures can increase as the pumping rate increases.

The most common cause of compliant about off-the-form finish are “blow-holes” caused by entrapped pockets of air held against the formwork, and details such as arrises not being replicated cleanly. SCC will normally achieve a better finish than conventional means. We have found that the following can assist in getting a quality finish:

- the correct spread as lower spread produces more blowholes,
- permeable formwork will typically have fewer blowholes,
- the right form oil applied evenly everywhere,
- steady controlled placement at a point and in a manner that minimises the air entrapment,
- ensuring the pump delivery hose is flowing full and under the concrete surface,
- generate flow energy in the SCC to encourage air release,
- getting the SCC to flow past the formwork “sweeping” attached air pockets away,
- placement rate shouldn’t exceed the rate of self-weight flow,
- pumping the SCC into the formwork from a pumping point at the bottom.

CASE STUDIES

As it was mentioned before, to obtain the best advantages of the SCC technology, the willingness of all actors is required. Some progressive precast operators enjoy the SCC technology advantages by producing superior quality products, and gain good profits. Here is a prime example.

After learning and understanding SCC technology a Northland pre-caster has developed a new septic tank system, which can only be economical and profitable if all components are made without much labour involved. The tank system consists of only three elements: the tank, the wing-wall, and the lid. All three elements are cast separately using SCC (Fig.6 through to 10). The wing-wall and the lid are structurally reinforced by steel fibres, as the tank was initially reinforced by the mesh, but currently all elements are made using SCC + Steel fibre combination. The final product is very presentable to the customers as the form finish is extremely good, which adds the value to the product. Minimum effort is required to successfully cast very complex shapes, especially wing-walls and lids (his estimation of labour saving was 80%). High strength (70-80MPa) and increased durability (fly ash was used) both add to the long-lasting maintenance free performance and to the value of the product as the result.

In addition to all above benefits, the environment in the factory is very pleasant. It is quite, clean and safe.
SCC with steel fibres is discharged into one of the five 50mm thick walls through the specially made steel funnel. SCC goes down to the bottom of the wall, through the 200x40 opening to the cylinder and the cone at the bottom of the cylinder, then through 200x40 openings at the bottom of the other 4 walls, and goes up to the top of those walls.

As it can be seen, SCC can be discharged using a skip, but most of the skips used in precast factories and at the construction sites are not suitable for holding, safe transportation of SCC, and controlling the discharge rates of SCC.

SCC can also be discharged straight from the chute of the delivery truck (see Fig 10 and 12).

SCC has been used to achieve extremely good surface finishes and sharp architectural detailing (Fig. 13).

SCC is often the only solution when there is no or very limited access for vibration and yet high requirements for concrete consolidation for structural performance are in place (Fig 14 and 15).
Placing SCC by pumping it into the formwork is easy and safe process. Pumping rates can be controlled better, which allows filling the space to the required level without unnecessary waste of concrete.

SCC is an ideal application for ‘stitching’ precast panels. It is fast and safe process, which at the end delivers high quality end result (Fig 16 & 17).

In a central city site, a tanked 7.5m by 5m by 3.5m deep lift shaft base needed to be constructed hard up against existing structures. This meant the tanking to the 200mm thick centrally reinforced walls had to be in place prior to pouring, putting it at great risk of damage during compaction with vibrators. There were also a number of set downs and inserts along the top of the walls that needed to be cleanly formed otherwise rework would be necessary. Solution: 13 cubic metres of SCC were pumped into place in 45min by the pump operator and a hoseman alone. Alternate loads of SCC were poured into opposite sides of the formwork and allowed to flow around the structure, filling up under setdowns as it went. Some topping out was required, but no rework at all was required (Fig. 18).

These are just some examples of SCC applications that have been carried out in the last 2 to 3 years.

Information regarding properties of hardened SCC in New Zealand is limited by reasonably good database on compressive strength data and random test results on shrinkage, durability, and other properties. Compressive strength of SCC varies from 45 to 80 MPa, but 90 and above MPa was achieved in laboratory trials. Some tests were carried out to investigate shrinkage, tensile strength, and chloride diffusion characteristics of SCC. These tests were done in comparison with normal high strength concrete and have indicated that hardened SCC properties are much the same or slightly improved. What was noticed is that mechanical properties of SCC depend on the type and quantity of fillers used. What it means is that SCC can be designed or optimised to meet any structural requirements including durability. But all this needs to be verified by the wider evaluation program.

**DESIGN ADVANTAGES**

A conscientious designer needs to consider the ease of construction and the likelihood that the actual quality of construction will match that assumed in the design. Both the plastic properties and the hardened properties of SCC work to the advantage of the designer bringing reality closer to the design concepts.

SCC will provide better assured quality particularly in the following area:

- **Durability:** The cover concrete is typically of better quality than is typical of equivalent normally placed concrete.
- **Strength:** Hardened properties are less dependent on the site handling and conditions.
- **Placement:** Greater surety of complete filling of joints with unsegregated concrete and proven improvement in top bar bond.
This can allow the designer to change the design concepts to produce more efficient and/or economical structures. Examples could be more slender columns by taking advantage of higher strength or more one-piece units reducing joints or bonds.

HOW TO SPECIFY SCC?

The major uncertainty is how to specify fresh properties of SCC and their acceptance criteria.

In the future SCC will be somehow categorised in the similar way as it is recommended in [9] and [10]. In the meantime New Zealand should follow the current worldwide practice of having mutual agreement on the test methods and performance criteria between user/specifier and supplier of SCC. All three parameters of SCC (filling ability, passing ability and stability) are determined while developing SCC and should be validated by the producer by means of demonstrational pour. Slump flow test seems to be a good measure of consistency of SCC on the job site and can also be used as a visual validation of stability of SCC. This approach has been successfully used in New Zealand for the last 3 years.

The specifiers and building contractors may consider the following example of how fresh SCC properties could be specified:

“Self-compacting concrete (SCC) to suit application with demonstration of SCC properties to the engineer’s and contractor’s satisfaction prior the first pour of SCC. Filling and passing ability parameters are to be agreed between the contractor and the supplier of SCC. On-site quality control includes assessment of the agreed flowability properties of SCC using the slump flow test with visual assessment of the stability of SCC.”

OBSTACLES TO ACCEPTANCE

It is not expected that SCC will replace more than a small percentage of the concrete currently being used, but it is much more than a niche product to use as a last resort. Unfortunately, this is how it is seen now mainly because of the price premium and lack of knowledge about SCC properties and benefits.

It could be said that the price obstacle partially stems from designers not considering the advantages SCC can offer when designing a structure, and the reasons for it not being considered is lack of knowledge about its properties and advantages. Overseas research into the properties of SCC has shown it to typically have hardened properties equivalent or superior to that of the concrete that would normally be used. Testing in New Zealand has confirmed a similar relationship but the perception still exists that because of its high flow and high admixture content, it is inferior in some way to normal concrete. Further research and dissemination of knowledge will allow designers to learn and trust SCC.

The other part of the price obstacle is the contractor being blinded to the potential savings and improved performance by the cost premium. This is due to a lack of experience with SCC how it can best be used. Only time and the use of SCC will give them the necessary confidence to cost a job using a more expensive product to give a lower overall cost.

FUTURE WORK, CHALLENGES

- There is a need to increase the knowledge in almost all aspects of SCC technology;
- There is a need to initiate national research programs to begin building a greater knowledge and confidence in SCC technology within the New Zealand construction industry;
- When the knowledge starts to grow, it will prompt the interest of specifiers, constructors and owners in the potential of the new technology, which will eventually reduce the gap in willingness between producers and users of SCC;
- We need to gain the experience by using more of SCC. It cannot be done without involvement of architects, designers, contractors, and estimators.

4. CONCLUSION

The world sees SCC as a milestone achievement in concrete technology. The more the world learns about it, the more obvious it is.

The common perception is that SCC is too expensive and that’s why it cannot be cost effective or even attractive to the customers, and this is not wise thinking. Number of overseas experiences and some of New Zealand progressive entrepreneurs have proven otherwise. They enjoy the overall benefit of producing high quality products, and providing much healthier environment to the workers and to the neighbourhood. The industry should look beyond the initial perception and realistically quantify the value SCC technology can deliver.
For the period of 2000–2003 New Zealand concrete ready mixed industry gained indispensable knowledge and experience in successful design and production of self-compacting concrete. In the ready mixed industry we are confident that we are able to produce self-compacting concrete to match the performance level to specific job requirements. In order to build a confidence of the whole industry, the greater knowledge and experience of other players of the industry is required, which can only be achieved with the willingness and active involvement of all actors into the Self-Compacting Concrete Technology.

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