A STUDY ON SELF COMPACTING CONCRETE MADE WITH LOCAL MATERIAL

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ABSTRACT

Recent remarkable changes in the construction environment are demanding improved technology for the production of high performance concrete with far greater workability, high strength and long durability. Therefore, a self-compacting concrete (SCC), which has excellent deformability and resistance to segregation and can be filled in heavily reinforced formwork without vibrators, was created. In order to verify the differences of the properties of hardened self-compacting concrete and normal vibrated concrete, various investigations have been carried out for establishing a rational mix-design and self-compactability testing method to make it a standard concrete. To achieve the performance goal, there are so many factors that have to be considered. It started from the application of local materials including the additive or admixture to enhance the flowability of concrete. It is followed by the concrete mix of varying design strength by using ordinary Portland cement (OPC) cement, aggregates of varying sizes, superplasticizers and fly ash which is expected to be effectively used for self-compacting concrete. The objective of this study is to find the local material that can be used as an admixture for self-compacting concrete (SCC). Local material that has been selected as an admixture is rubberwood ash. Ten different concrete mix designs are used as a mixture for sample of cube, cylinder and beam. Method that has been used to determine the self-compacting concrete (SCC) are U box/ U- flow test and slump flow test. Standard testing methods to determine the strength of concrete are cube test for compressive strength, cylinder splitting test for tensile strength and flexural beam test for flexural strength. Through U flow test and slump flow test, it was found that concrete mix with rubberwood ash as an admixture failed to be classified as a self-compacting concrete (SCC). It was also found that concrete mix with rubberwood ash will decrease in compressive strength, tensile strength and flexural strength. Strength of concrete decrease with the increasing of amount rubberwood ash added.

INTRODUCTION

Self-compacting concrete (SCC) represents one of the most outstanding advances in concrete technology during the last decade. It describes a concrete with the ability to compact itself only by means of its own weight without the requirement of vibration. SCC meanwhile is spread all over the world with a steadily increasing number of applications where the use of SCC offers many benefit to the construction practice. The application of SCC can produce self-compacting concrete utilizing local material. It also can determine its properties and performance under varying curing conditions and the correlation between the various test; U-flow test, V-flow test and standard test.

Self-compacting concrete also leads to a reduction of noise during casting, better working conditions and the possibility of expanding the placing times in inner city areas. Other advantages of SCC are an improved homogeneity of the concrete production and the excellent surface quality without blowholes or other surface defects.

The use and quality of local materials is the most important factor to ensure the performance of SCC. It includes the number of concrete mixes of varying design strength and the method of testing to get the results. Actually, the basic components for the mixed composition of SCC are the same as used in conventional concrete. However, to obtain the requested properties of fresh concrete, in SCC a higher proportion of ultrafine materials and the incorporation of chemical admixtures, in particularly an effective superplasticizer, are necessary.

Often the material costs of SCC will be higher than the equivalent material costs of a normal vibrated concrete. However, when SCC is sensibly utilized, the reduction of costs caused by better productivity, shorter construction time and improved working conditions will compensate the higher material costs and, in many cases, may result in more favorable prices of the final product.

MATERIALS AND METHODS

The History of SCC

The history and development of SCC can be divided into two key stages: its initial development in Japan in the late 1980s and its subsequent introduction into Europe through Sweden in the mid- to late-1990s.

SCC was first developed in Japan in 1988 in order to achieve more durable concrete structures by improving the quality achieved in the construction process and the placed material. The removal of the need for compaction of the concrete reduced the potential for durability defects due to inadequate compaction (e.g. honeycombing). The use of SCC was also found to offer economic, social and environmental benefits over traditional vibrated concrete construction. These benefits included faster construction and the elimination of noise due to vibration. One of the main drivers for the development of the technology was the reduction in the number of skilled site operatives that the Japanese construction industry was experiencing in the 1980s. The use of SCC meant that less skilled labor was required for the placing and finishing of the concrete SCC was developed from the existing technology used for high workability and underwater concretes, where additional cohesiveness is required.

All studies concentrated upon high-performance and super-workable concretes and their fresh properties such as filling capacity, flowability and resistance to segregation. The first significant publication in which 'modern' SCC was identified is thought to be a paper from the University of Tokyo by Ozawa et al. in 1992. The term 'self-compacting concrete' is not used within the paper, although a high performance concrete was produced which possessed all the essential properties of a self-compacting concrete mix. In the following few years many research papers were published on concretes such as super-workable, self-consolidating, highlyworkable, self-placeable and highly-fluidised concretes, all of which had similar properties to what we now know as SCC. These were mainly papers on work into the mix design of what would become 'SCC' and its associated fresh properties. In 1993, research papers were beginning to be published of case studies on the use of these early forms of 'SCC' in actual applications. One of the first published references utilising the term 'selfcompacting' was in Japan in 1995. After the development of this prototype SCC, intensive research began in many places in Japan, especially within the research institutes of large construction companies, and as a result, SCC has now been used in many practical applications.

New SCC technology can eliminate or dramatically reduce the need for vibration, making it possible to reduce labor costs while improving the overall work environmento for construction personnel. Faster placement and less finishing time can improve productivity and profitability. Increased flowability and consolidation can improve appearance and enhance the durability of the finished element.

Mix Design

In this study, concrete ingredients are cement (Ordinary Portland Cement), sand (5mm), gravel (10 mm to 5 mm), water, local material (rubber wood ash) and superplasticisers (Glenium C-380). All ingredients are mixed into the different mix proportion of water cement ratio and different mix proportion of percentage rubber wood ash. The mix proportion is shown below;

Mix 1: 0.6 w/c ratio (compression strength test, tensile strength, flexural strength)
Mix 2: 0.65 w/c ratio (compression strength test, tensile strength, flexural strength)
Mix 3: 0.70 w/c ratio (compression strength test, tensile strength, flexural strength)
Mix 4: 0.75 w/c ratio (compression strength test, tensile strength, flexural strength)
Mix 5: 0.80 w/c ratio (compression strength test, tensile strength, flexural strength)
The water to cement ratio is selected to give the required strength, better workability and suitable for principle of self-compacting concrete. The amount additive of rubber wood ash in the mix is around 1 % of total weight mix. For each series, total specimens will be cast is around 60 cubes for compression, 30 cylinders for tensile and 30 beams for flexural.

Below is the list of proportion mix design with the percentage of rubberwood ash with w/c ratio of 0.6 %;

Mix 6 – 1% rubber wood ash of the total weight mix
Mix 7 – 0.75% rubber wood ash of the total weight mix
Mix 8 – 0.5% rubber wood ash of the total weight mix
Mix 9 – 0.25% rubber wood ash of the total weight mix

Mix 10 – 0% rubber wood ash of the total weight mix (normal concrete for control purposes)

From this mix, we can get the suitable percentage that can fill the rubber wood ash in concrete for get the principle of self-compacting concrete and can increase strength and workability.

SCC Requirements

SCC can be designed to fulfill the requirements regarding density, strength development, final strength and durability. These aspects should therefore be considered during designing and specifying SCC. Special care should also be taken to begin curing the concrete as early as possible. The workability of SCC is higher than the highest class of consistence described and can be characterized by the following properties: 1) filling ability, 2) passing ability, 3) segregation resistance, 4) a concrete mix can only be classified as Self-compacting Concrete if the requirements for all three characteristics are fulfilled.

TEST METHODS

Introduction

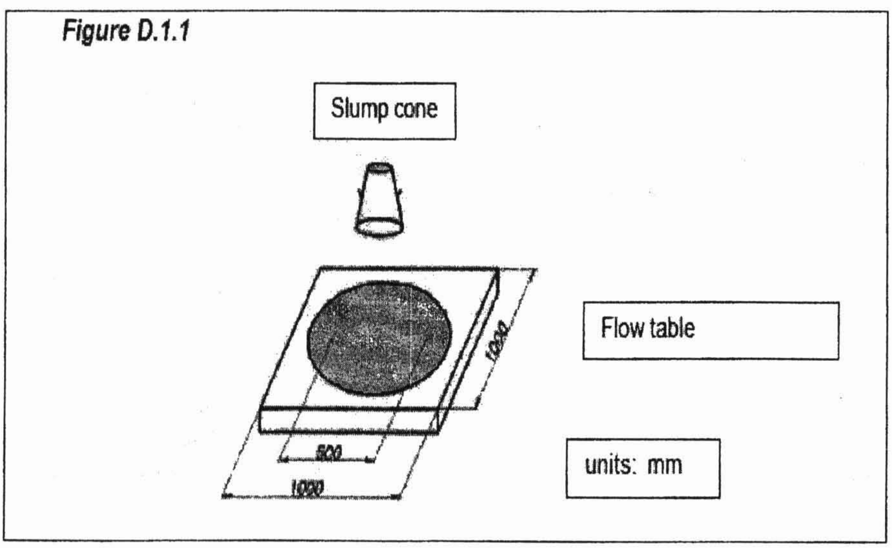
Many different test methods have been developed in attempts to characterize the properties of SCC. Similarly no single method has been found which characterizes all the relevant workability aspects so each mix design should be tested by more than one test method for the different workability parameters. It is important to appreciate that none of the test methods for SCC has yet been standardized, and the tests described are not yet perfected or definitive. The methods presented in the study here are descriptions rather than fully detailed procedures.

For the initial mix design of SCC all three workability parameters need to be assessed to ensure that all aspects are fulfilled. A full-scale test should be used to verify the self-compacting characteristics of the chosen design for a particular application.

Slump flow test

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete. It is the most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without blocking, but may give some indication of resistance to segregation. Figure D.1.1 show the slump flow test equipment.

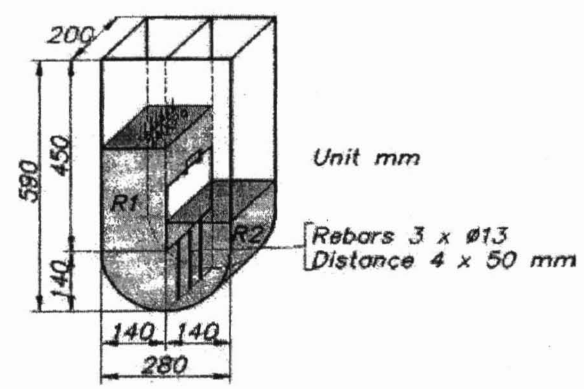
Figure D.1.1 : Slump Flow Test



U box/ U Flow Test Method

Sometimes the apparatus is called a "box-shaped" test. The test is used to measure the filling ability of self-compacting concrete. The apparatus consists of a vessel that is divided by a middle wall into two compartments, shown by R1 and R2 in Fig.D.7.1 an opening with a sliding gate is fitted between the two sections. Reinforcing bars with nominal diameters of 13 mm are installed at the gate with centre-to-centre spacing of 50 mm. This creates a clear spacing of 35 mm between the bars. The left hand section is filled with about 20 litre of concrete then the gate lifted and concrete flows upwards into the other section. The height of the concrete in both sections is measured. Figure D.7.1 show the equipment of U box and the actual dimension.

Figure D.7.1 : U Box



If the concrete flows as freely as water, at rest it will be horizontal, so H1 - H2 = 0. Therefore the nearer this test value, the 'filling height', is to zero, the better the flow and passing ability of the concrete

RESULTS AND DISCUSSION

Concrete that mixed with rubberwood ash as an admixture is found reduced in their compressive strength. Furthermore, their compressive strength decreased with the increasing amount or percentage of the rubberwood ash added.

Self Compacting Concrete

For concrete to be classified as a self-compacting concrete, it must meet several criteria. The most important criteria is it workability @ known as filling ability and passing ability. In this project, method that has been used to determine the self-compacting concrete are U-flow test and slump flow test. Through U-flow test, it is found that rubberwood ash is not suitable as an admixture or additive for self compacting concrete. For all amount of rubberwood ash added as an admixture, it is failed to meet the minimum level of workability that the concrete can be classified as a self-compacting.

Table 1 : w/c Ratio with 1.0% of Rubberwood Ash

w/c ratio with 1.0% of rubberwood ash	U flow test
0.60 %	20 mm
0.65 %	20 mm
0.70 %	25 mm
0.75 %	25 mm
0.80 %	30 mm

Table 2 : % of Rubberwood Ash with 0.6 % w/c Ratio

% of rubberwood ash with 0.6 % w/c ratio	U flow test
0.00 %	5 mm
0.25 %	10 mm
0.50 %	15 mm
0.75 %	20 mm
1.00 %	20 mm

Another test to determine self-compacting concrete is by slump flow test. Result from this test also shows that rubberwood ash fail to increase the workability of concrete to be classified as a self-compacting concrete.

Table 3 : w/c Ratio with 1.0% of Rubberwood Ash Added

w/c ratio with 1.0% of rubberwood ash added	slump flow test
0.60 %	400 mm
0.65 %	400 mm
0.70 %	405 mm
0.75 %	410 mm
0.80 %	420 mm

Table 4 : % of Rubberwood Ash with 0.6 % w/c Ratio

% of rubberwood ash with 0.6 % w/c ratio	slump flow test
0.00 %	330 mm
0.25 %	335 mm
0.50 %	340 mm
0.75 %	390 mm
1.00 %	400 mm

Compressive Strength

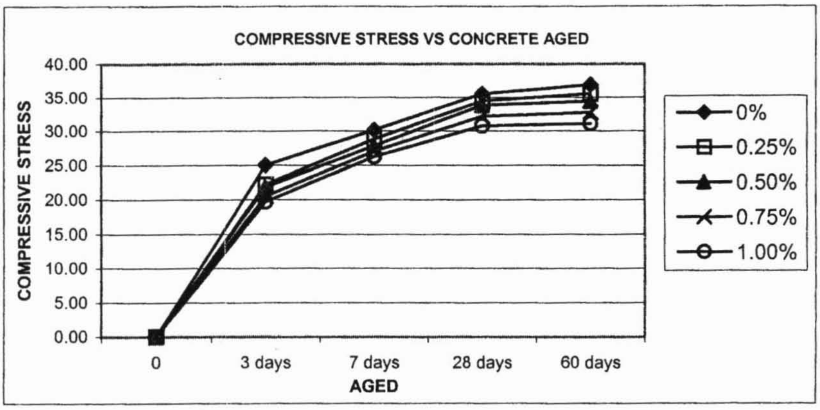
It is found that the compressive strength of sample testing increase with it's aged. It follows the pattern of the standard of control sample. It's also found that the compressive strength of sample decrease with the increase of amount rubberwood ash added. This indicates that the amount of rubberwood ash contribute to the decrease of the compressive strength of concrete.

For concrete without rubberwood ash (RWA) added, the stress for 28 days is 35.53 N/mm^2, with 0.25 % RWA, stress is 34.46 N/mm^2, with 0.5 % RWA, stress is 33.82 N/mm^2, with 0.75 %, stress is 32.14 N/mm^2 and with 1.0 % RWA the stress decrease to only 30.75 N/mm^2.

Table 5 : Concrete Aged vs Compressive Stress

Rubber ash	0.00%	0.25%	0.50%	0.75%	1.00%
3 days	25.02	22.23	21.48	20.53	19.72
7 days	30.13	28.83	27.85	27.05	26.26
28 days	35.53	34.46	33.82	32.14	30.75
60 days	36.92	35.56	34.42	32.70	31.06

Graph 1 : Compressive Stress vs Concrete Aged

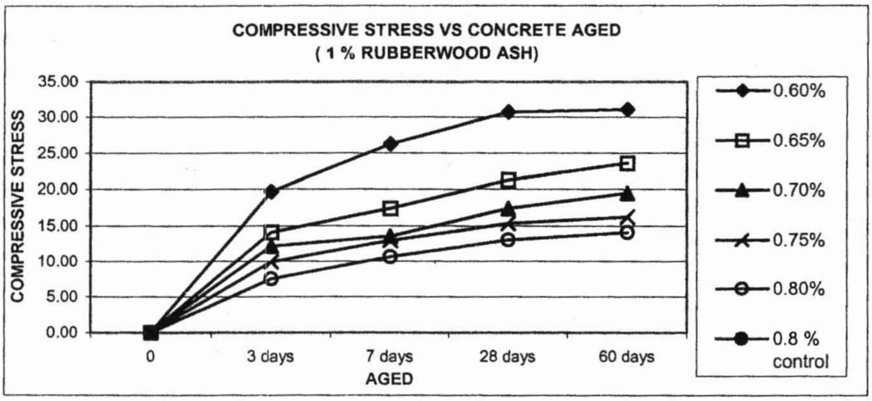


In term of water cement ratio, sample with 1 % rubberwood ash added are mixed with different water cement ratio. This sample then has been tested using standard compression test for concrete. For concrete mixed with 0.6 % w/c ratio the stress for 28 days is 30.75 N/mm^2, with 0.65 % w/c ratio, stress is 21.25 N/mm^2, with 0.7 % w/c ratio, stress is 17.34 N/mm^2, with 0.75 % w/c ratio, stress is 15.34 N/mm^2 and with 0.8 % w/c ratio the stress decrease to only 13.01 N/mm^2.

Table 6 : Concrete Aged vs Compressive Stress

Water cement ratio	0.60%	0.65%	0.70%	0.75%	0.80%
3 days	19.72	14.04	12.14	9.89	7.50
7 days	26.26	17.36	13.58	12.95	10.56
28 days	30.75	21.25	17.34	15.34	13.01
60 days	31.06	23.63	19.54	16.23	14.09

Graph 2 : Compressive Stress vs Concrete Aged



Tensile Strength

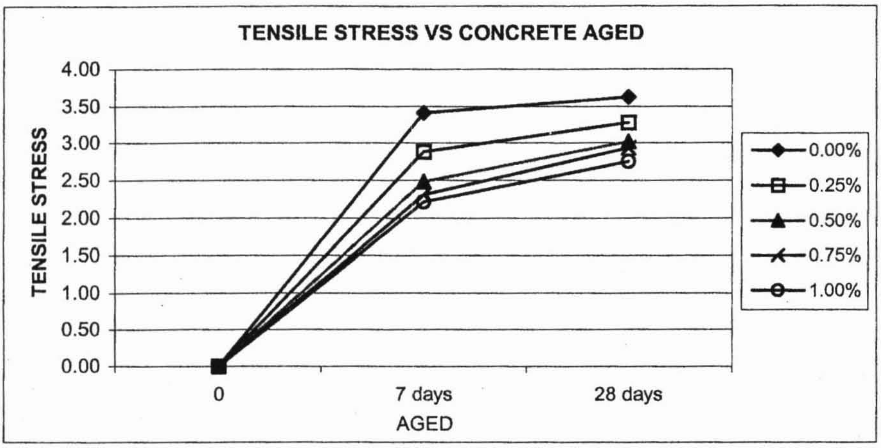
Value of tensile strength of concrete is obtained by using cylinder splitting tension test. Result from this test shows that the tensile strength of concrete increase with it's aged. It shows that the tensile strength decrease with the increase of amount rubberwood ash added. This mean that amount of rubberwood ash added contribute to the decrease of tensile strength of concrete itself.

For concrete without rubberwood ash added, the stress for 28 days is 3.63 N/mm^2, with 0.25 % RWA, stress is 3.28 N/mm^2, with 0.5 % RWA, stress is 3.02 N/mm^2, with 0.75 %, stress is 2.93 N/mm^2 and with 1.0 % RWA the stress decrease to only 2.75 N/mm^2.

Table 7 : Concrete Aged vs Tensile Stress

Rubber Ash	0.00%	0.25%	0.50%	0.75%	1.00%
7 days	3.41	2.88	2.48	2.31	2.21
28 days	3.63	3.28	3.02	2.93	2.75

Graph 3 : Tensile Stress vs Concrete Aged



Flexural Strength

Value of flexural strength of concrete is obtained by using flexural test for beam. Beam with standard size of 150 mm x 150 mm x 700 is used.

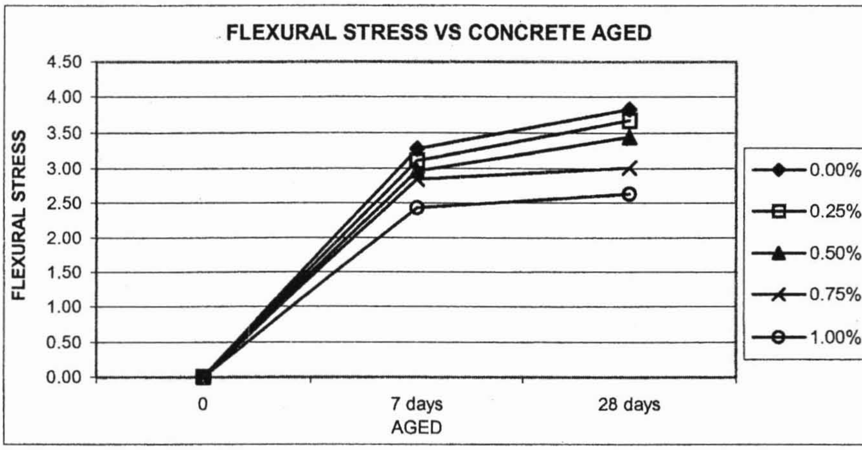
Result from this test shows that the flexural strength of concrete increase with it's aged. It also shows that the flexural strength decrease with the increase amount of rubberwood ash added. This indicates that amount of rubberwood ash added contribute to the decrease of flexural strength of concrete itself.

For concrete without rubberwood ash added, the stress for 28 days is 3.83 N/mm^2, with 0.25 % RWA, stress is 3.67 N/mm^2, with 0.5 % RWA, stress is 3.44 N/mm^2, with 0.75 %, stress is 3.01 N/mm^2 and with 1.0 % RWA the stress decrease to only 2.63 N/mm^2.

Table 8 : Concrete Aged vs Flexural Stress

Rubber Ash	0%	0.25%	0.50%	0.75%	1.00%
7 days	3.28	3.11	2.96	2.84	2.43
28 days	3.83	3.67	3.44	3.01	2.63

Grapf 4 : Flexural Stress vs Concrete Aged



CONCLUSION

Through this project, by using rubberwood ash as an admixture for concrete, it is found that concrete failed to be classified as a self-compacting concrete (SCC). It's also found that compressive, tensile and flexural strength of concrete also reduced with the increase of the amount rubberwood ash added. It shows that rubberwood ash is not suitable as an admixture for self-compacting concrete (SCC).

As a suggestion for the next project, researchers should find other local materials that can improve the workability of concrete and as a result concrete can be classified as a self-compacting concrete (SCC).

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