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## Quality Control and Robustness of SCC, Part 2

**ACI Spring 2012 Convention**  
**March 18 – 21, Dallas, TX**



**Niels Nielsen** is manager and 50% owner of the company Convi. The company is developing, producing and selling consistency measuring devices. He is born in Denmark in the year 1951 and is still living there. In 1975 he graduated as Diploma Engineer in mechanical design. After graduating he started designing equipment and plants for the concrete industry. For 27 years he did his design work for the company Skako A/S in Denmark having titles as Design Engineer, RD-Manager and Technical Manager. He saw the need of improving consistency control in the concrete production especially when producing SCC. In 2005 he started the company Convi. The company is based on the idea of improving consistency control by measuring rheology values of the concrete during mixing and thus being able to adjust these while the concrete is still in the mixer.




## The Use of the Visco Probe to Control SCC Rheology During Production

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### Outline

- Introduction
- Visco Probe system
- Study, 4C-Rheometer – Visco Probe
- Quality control issues

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### Introduction

The SCC is sensitive to almost all changes in the materials and in the production process.

There is a need of controlling rheology to control the production of SCC.

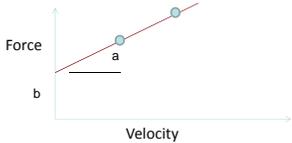
The Visco Probe system measure the rheological behavior directly in the mixer.

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### Introduction

The Bingham Model



- It takes a certain force to start the shear. It is the yield stress
- Increasing the shear velocity increases the shear force
- The increase of the force in relation to velocity is linear
- The incline of this line is the plastic viscosity
- Expressed in an equation: Force = a\*Velocity + b
- The a and b values provides all information of the concrete's flowability

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### The Visco Probe system

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### The Visco Probe system

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### The Visco Probe system

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### The Visco Probe system

**Visco Probe 1**

Product overview

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### The Visco Probe system

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### Study

A study was made by The Danish Technological Institute. [www.dti.dk](http://www.dti.dk)

The aim of the study was to compare the Visco Probe response in full scale production with fundamental values of yield stress and plastic viscosity measured by the 4C-Rheometer.

4C-Rheometer

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### Study

#### Test program

Two days test program at CRH facilities in Hobro, Jutland. SCC is the only concrete type used to produce prefab prestressed concrete elements of various kind.

Mixer type: Haarup 3000 Litres

#### The Visco Probe



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### Study

#### Test program

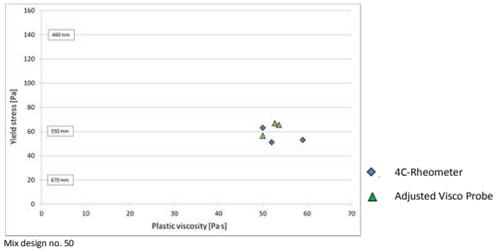


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### Study

#### Results



Mix design no. 50

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### Study

#### Conclusion

The test included 21 SCC batches.

The test included 5 different mix designs

A reasonable correlation was obtained on the plastic viscosity and yield stress. Both within the same mix design series and across mix designs.

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### Quality control issues

It takes a well operated and equipped batching and mixing plant to produce the SCC with high quality and uniformity

Accurate batching of all materials

- Measuring and adjusting according to moisture content in the incoming materials
- A controlled mixing cycle
- An efficient mixer able to handle the special demands for mixing SCC

It takes skilled people to make the right mix designs, day to day decisions and even batch to batch decisions

- QC of the incoming materials
- Making robust and cost efficient mix designs
- Defining the right flow properties of the SCC → good filling of the mould → good surface finish on the poured products
- Defining the best pattern of filling the moulds

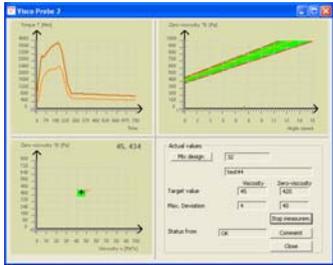
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### Quality control issues

#### Mixer efficiency

The Visco Probe is monitoring and logging the mixing (homogenising) process



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### Quality control issues

#### Mixer efficiency

Screenshots showing problems in the mixer performance

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### Quality control issues

The Visco Probe is

- Measuring in the full batch
- Measuring in all batches
- Measuring when all materials are in the mixer
- Measuring the rheological values: plastic viscosity and yield stress
- Correction is possible before the concrete leaves the mixer

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### Quality control issues

#### Adjustment by adding water

Measuring and adding water

Control at the end of mixing time

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### Quality control issues

#### Documentation of the adjustments

Batch	Water		Viscosity			Yield value				
	Target	Added	Target	Measure	1. contr.*	2. contr.*	Target	Measure	1. contr.	2. contr.
1	10,06	10,60	36	52	33	35	300	358	330	300

Tailing: 2,0  
Correction per unit per m<sub>3</sub>: 0,722

- \* 1. control: At end of mixing time
- \* 2. control: When discharging the mixer

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### Quality control issues

#### Robust mix designs

- Big efforts are made to make robust SCC
- Often high contents of powder, fines and chemicals are used to cover over lack in control during the production process
- With the Visco Probe each batch can be controlled to be in the center of the "robustness window"
- This enables to work with a smaller "robustness window", resulting more **cost-efficient mix designs**.

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### Quality control issues

#### Robust mix designs

Robustness window

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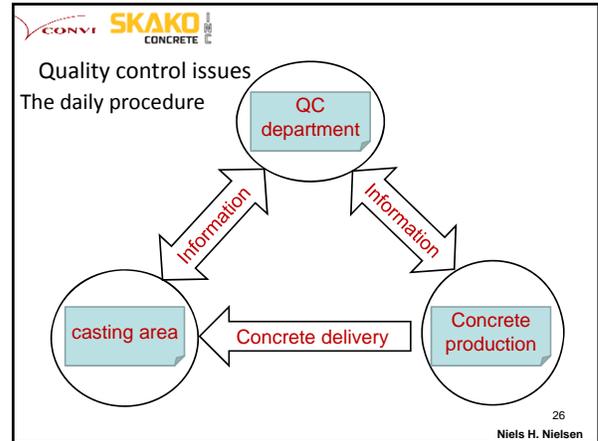
### Quality control issues

#### Concrete surface quality

- Define and control the casting patterns
- Control and document rheology (flow properties) for each batch

Having this quality issue under control leads to better looking products and brings down the cost of surface repair

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The Visco Probe doesn't give all answers to production of high quality SCC, but it is a huge step in the right direction.

Thank you for your attention

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