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Das Betonrheometer BT2 zur Bestimmung der rheologischen Eigenschaften selbstverdichtender Betone - Möglichkeiten und Entwicklungspotential

The concrete rheometer BT2 for assessment of the rheological properties of Self-Compacting Concrete – scope and potential for development

Florian Fleischmann
Wolfgang Kusterle

Contents

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Introduction

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- Control of the flowability of SCC
  - Visual control; laboratory technician

Introduction

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- Control of the flowability of SCC
  - Single-Point Tests (V-Funnel Test, Slump Flow, etc.)

  - Advantages: simple, fast, suitable for construction site
  - Disadvantages: empirical, no detailed information about rheological properties

Introduction

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- Control of the flowability of SCC
  - Measuring required mixing energy

Introduction

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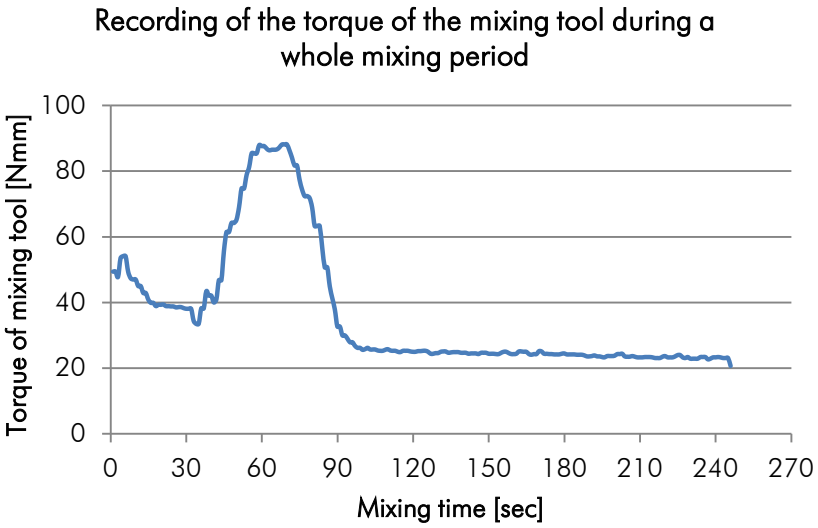
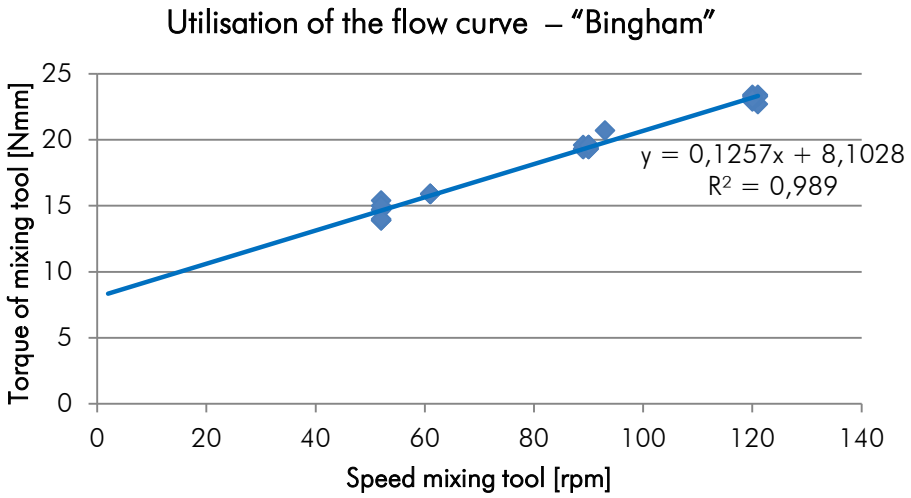
- Control of the flowability of SCC
  - Recording energy consumption of concrete mixer





Introduction

- Control of the flowability of SCC
  - Multiple-Point Tests

Tattersall Two-Point Rheometer

BTRHEOM

BML Viscometer

Eric P. Koehler, W.R. Grace & Co.: Test Methods for Workability and Rheology of Fresh Concrete, ACI Fall Convention November 2009.

Introduction

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- Control of the flowability of SCC
  - Multiple-Point Tests
    - Advantages: Rheological properties
    - Disadvantages: ⇨ permanent shearing of the specimen
      ⇨ slipping / segregation
      ⇨ tricky handling
      ⇨ setting and stiffening of the concrete is affected

Introduction

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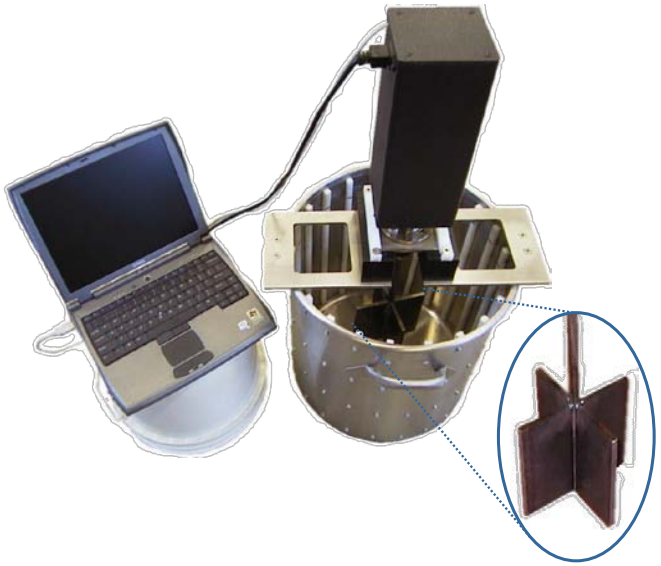
- Control of the flowability of SCC
  - Multiple-Point Tests



ICAR
Rheometer

Eric P. Koehler, W.R. Grace & Co.: Test Methods for Workability and Rheology of Fresh Concrete, ACI Fall Convention November 2009.

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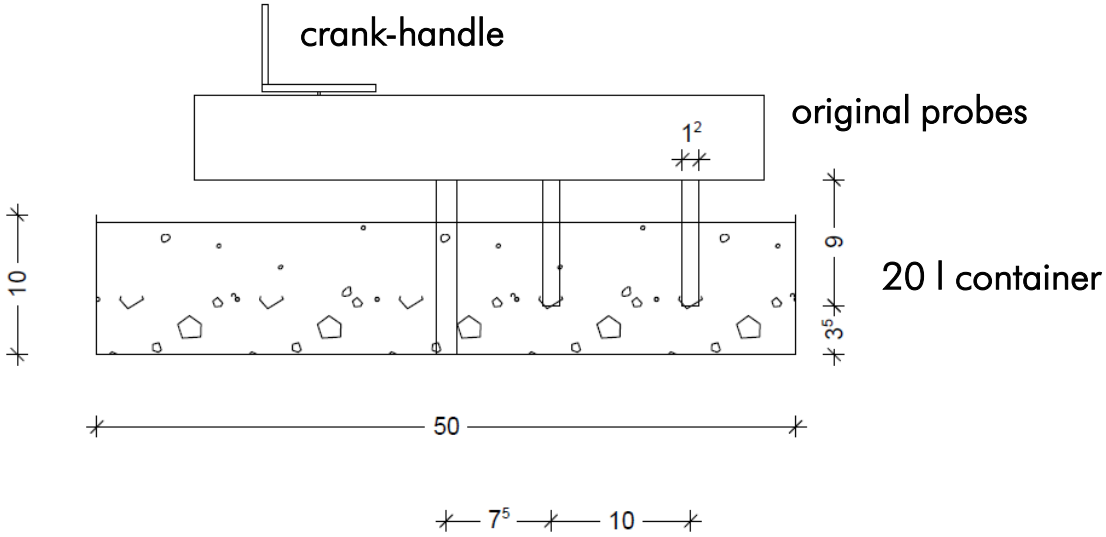
The Concrete Rheometer BT2



The Concrete Rheometer BT2

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- How it works
  - Two probes with different radius rotate around a centric axis
  - Measurement of the flow resistance at different load levels (different track speed)
  - Regression line ⇒ flow curve with relative Yield Stress and relative Plastic Viscosity

The Concrete Rheometer BT2

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- Advantages
  - Portable
  - Short measurement
  - No problems with cylinder geometry
  - No slipping / segregation
  - Measurement in fresh, unsheared concrete (one revolution)

The Concrete Rheometer BT2

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original BT2

- First measurements on SCC
- Results: data were not exact enough

The Concrete Rheometer BT2

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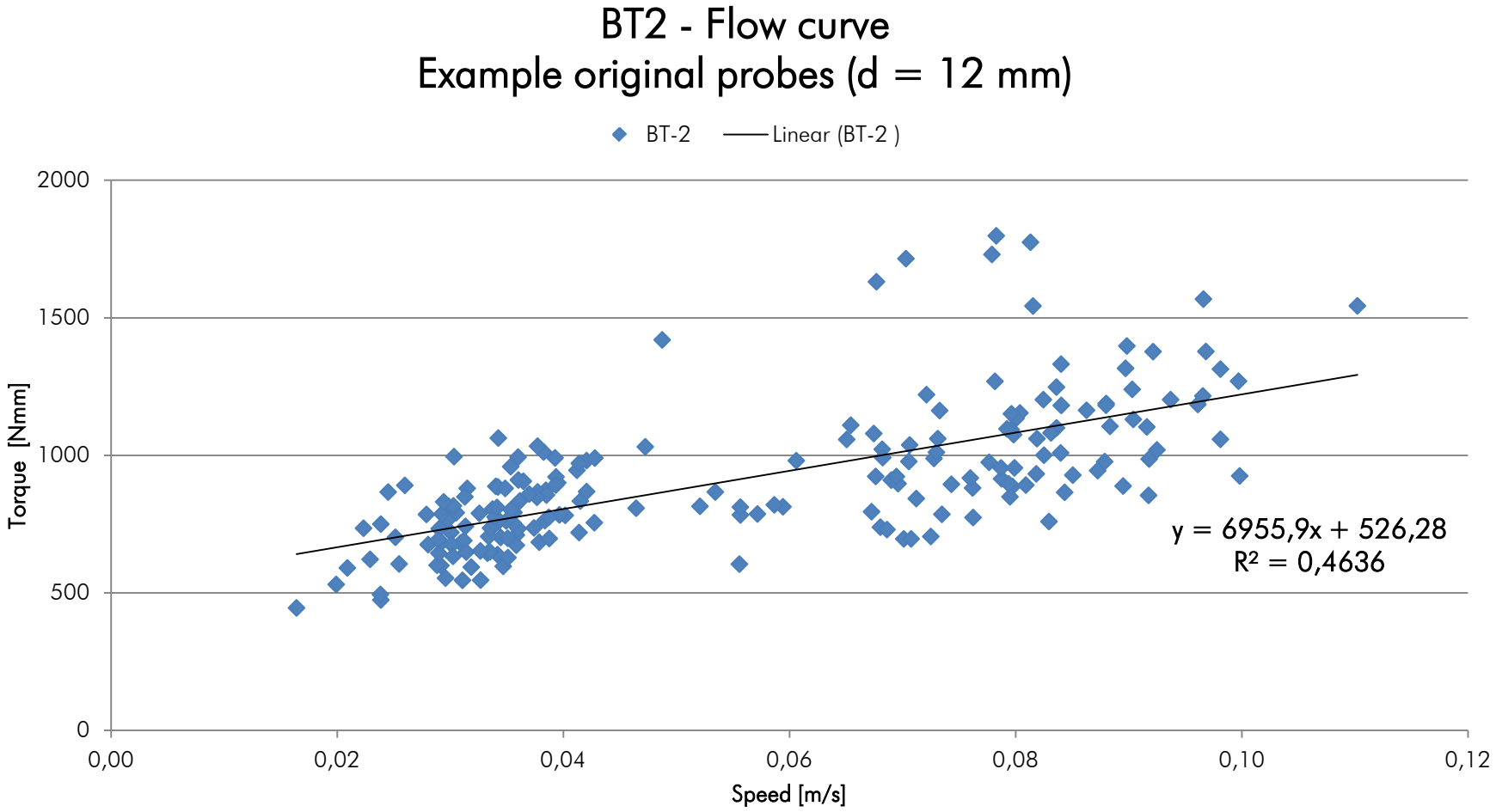

Further development of the BT2

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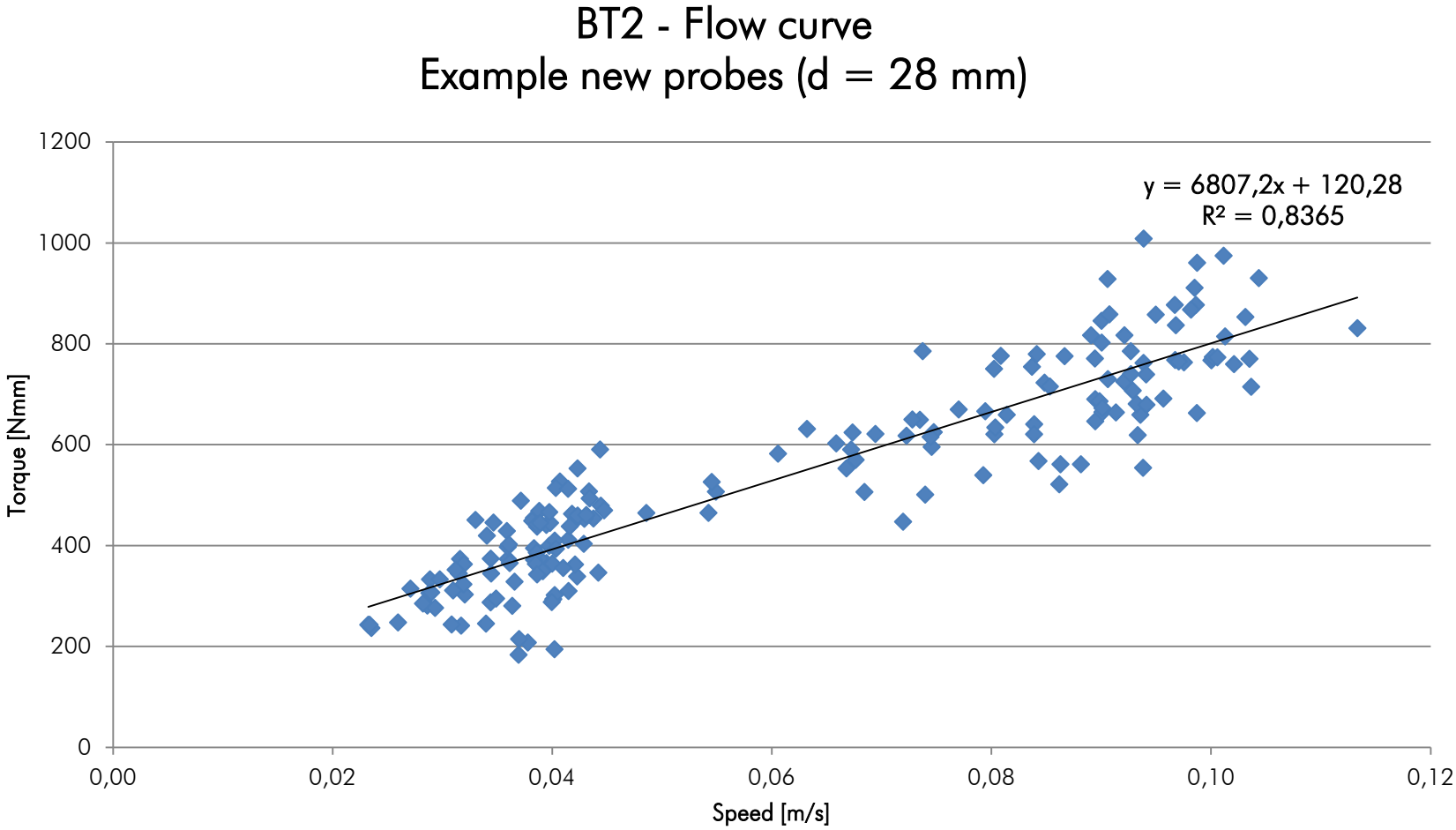
original BT2

- First measurements on SCC
- Results: data were not exact enough

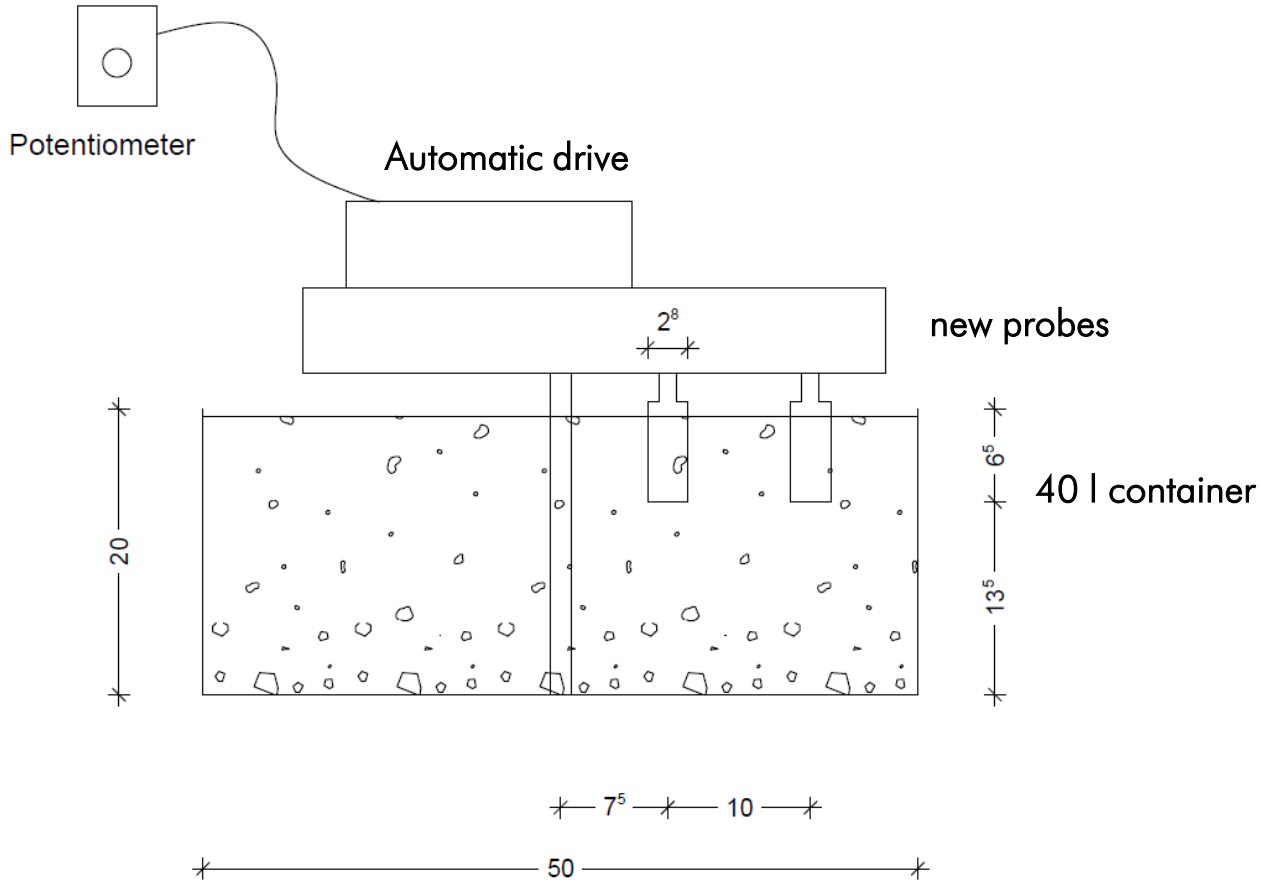
new probes

- More reliable data
- But still too inexact for very flowable SCC
- Flow curve indistinct
- Blocking by settled aggregates

Further development of the BT2



Further development of the BT2



Further development of the BT2

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Deeper specimen container and automatic drive

- Flow curve with yield stress, plastic viskosity and structural break down
- Stress growth test with static and dynamic yield stress
- No blocking

Software Update

- Exact data at low shear speed

Measurements with new BT2

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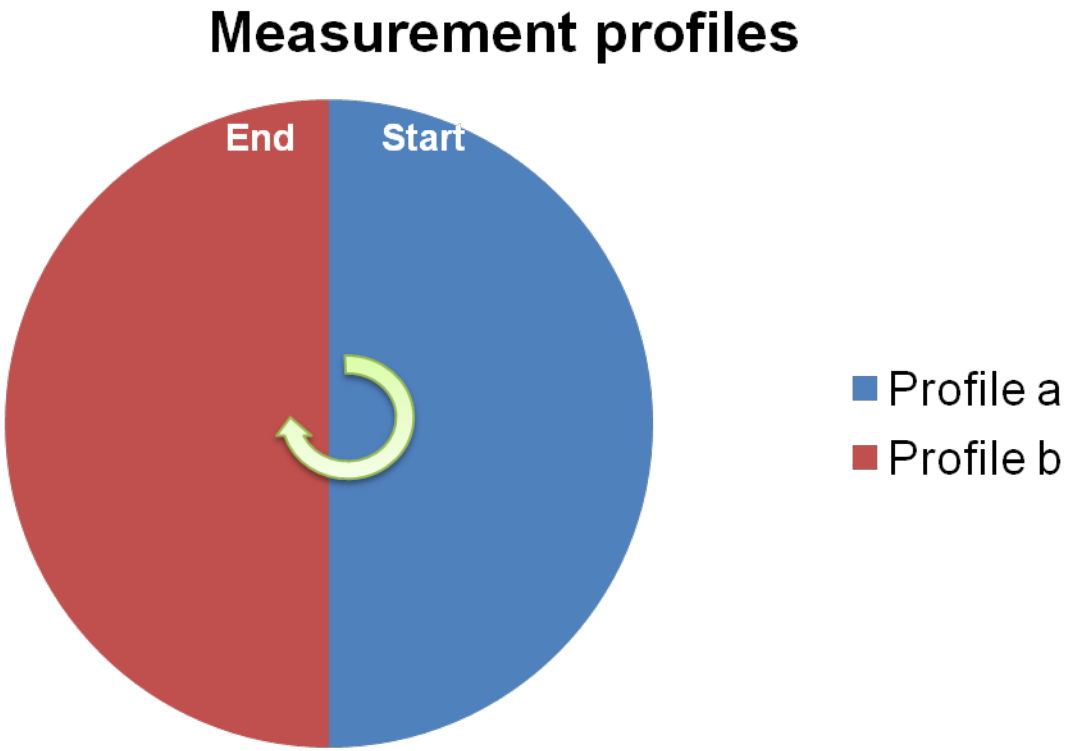
- Measuring process:



Measurements with new BT2

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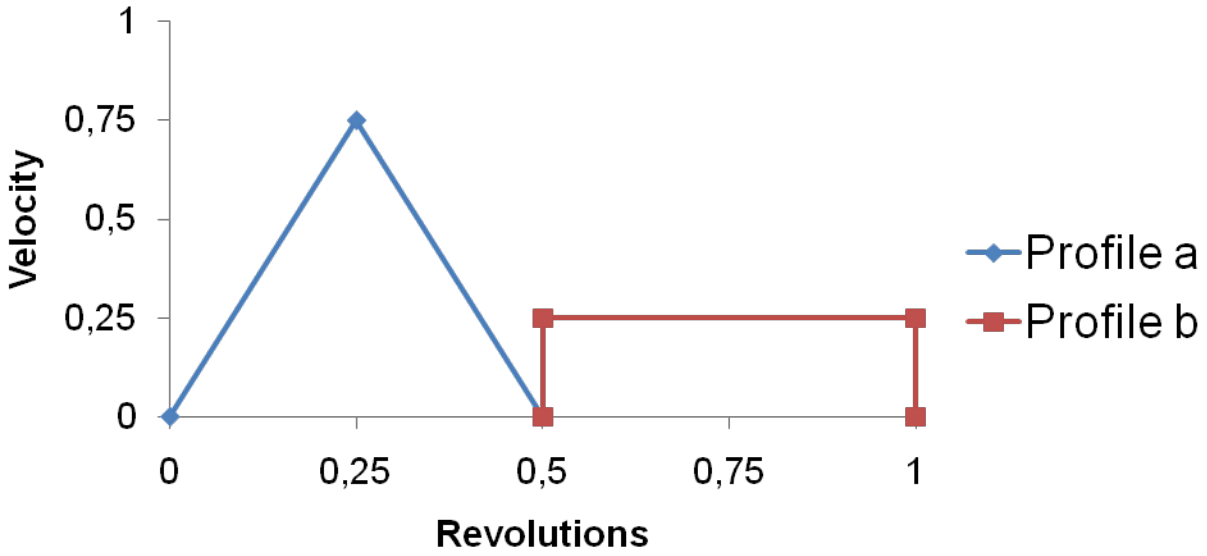
- Measurement profiles



Measurements with new BT2

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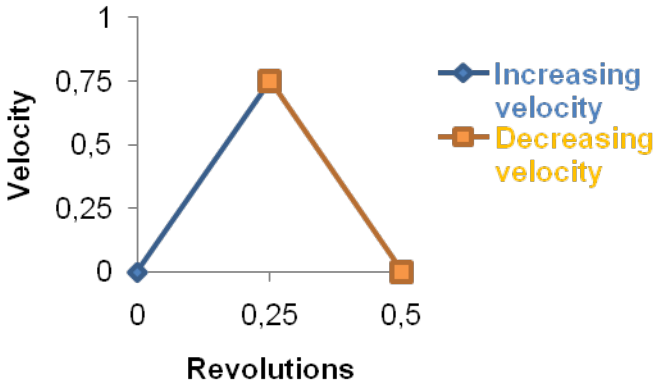
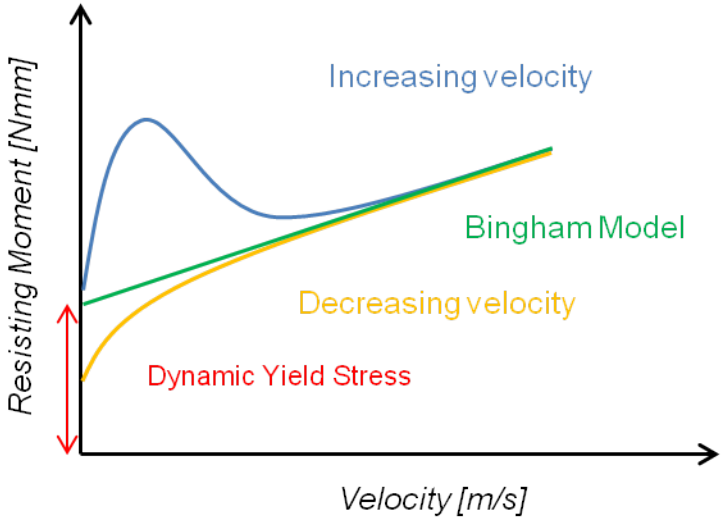
- Measurement profiles
  - Profile a
    - Setting: Speed –controlled mode with increasing and decreasing velocity
    - Result: flow curve with
      - rel. yield stress
      - rel. viscosity





Measurements with new BT2

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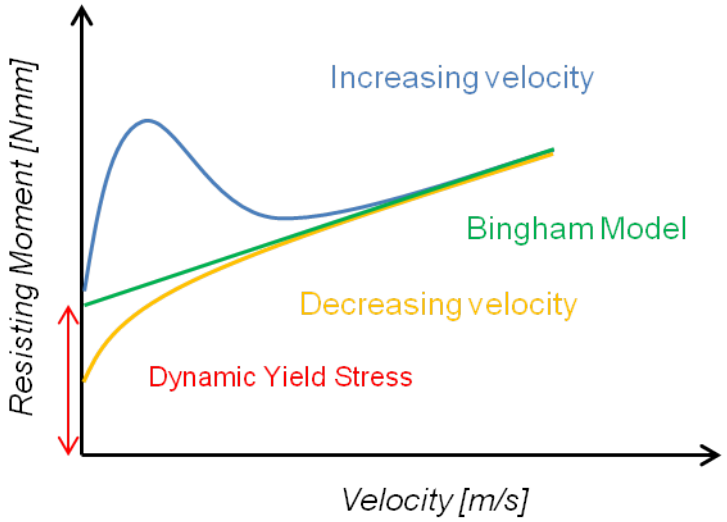
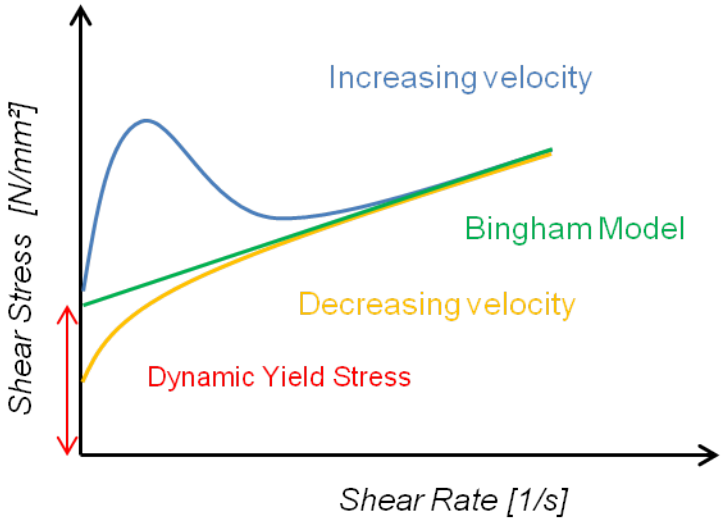
- Measurement profiles
  - Profile a





Measurements with new BT2

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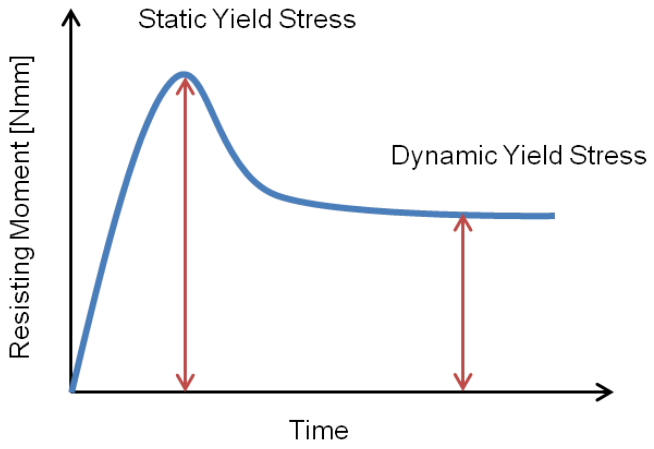
- Measurement profiles
  - Profile b
    - Setting: continual low speed
    - Result: Torque vs. time; "Stress Growth Test"
      - Static Yield Stress
      - Dynamic Yield Stress



Measurements with new BT2

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- Measurement data
  - Data are recorded by both probes
  - Both probes are evaluated separately
  - Good correlation between the probes
  - Utilisation with „Bingham-Model“
  - Only one probe necessary for getting results
  - Second Probe used for control

Test Results

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- 1. Test series:
  - Optimization of the test profiles and settings
- 2. Test series
  - Variation in water content
    (SF 550 mm - 820 mm)
  - Target: Impact of different water content on the rheological properties
  - Result: BT2 delivers reliable information regarding the water content

Test Results

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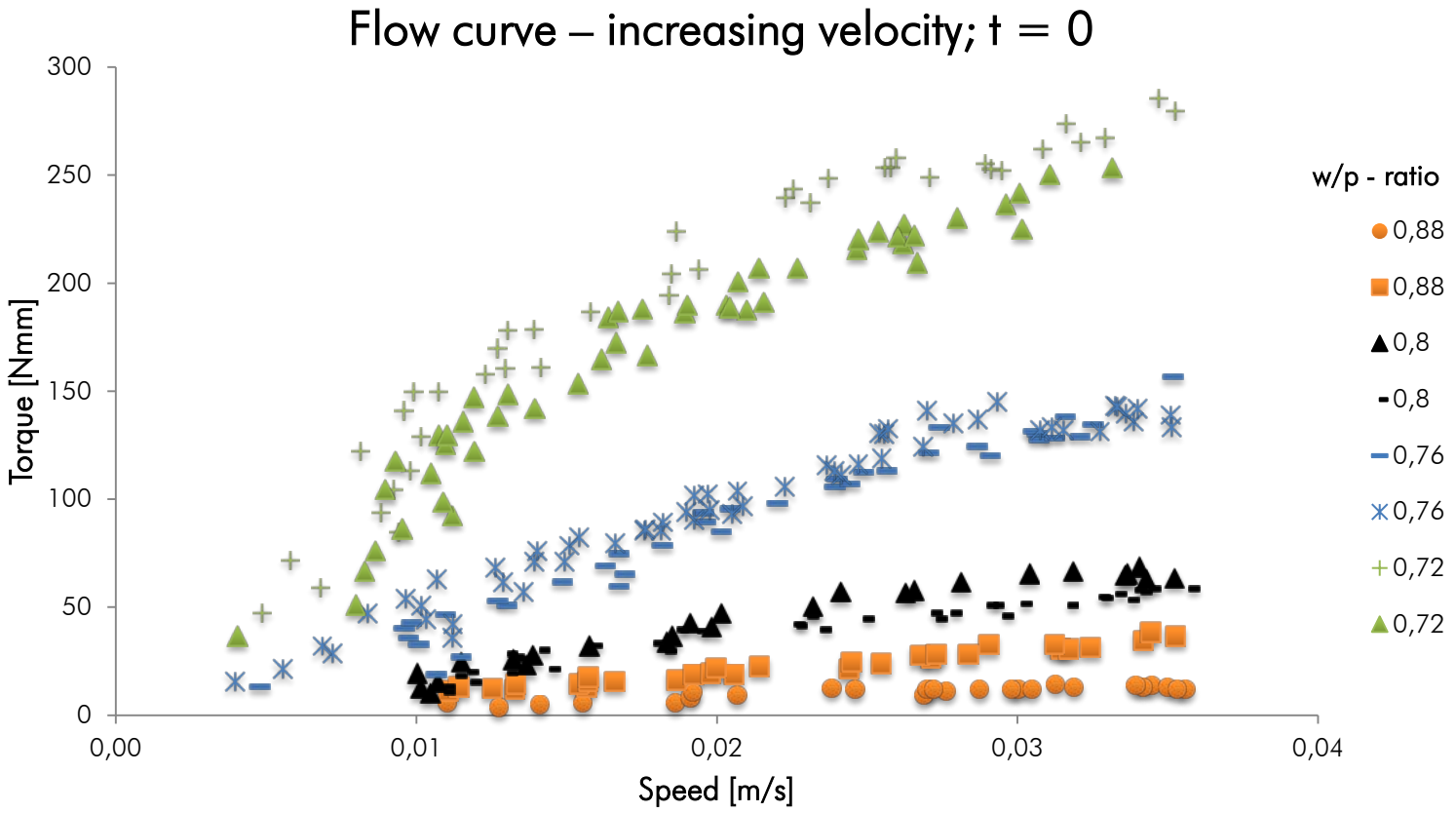
- Profile a



Test Results

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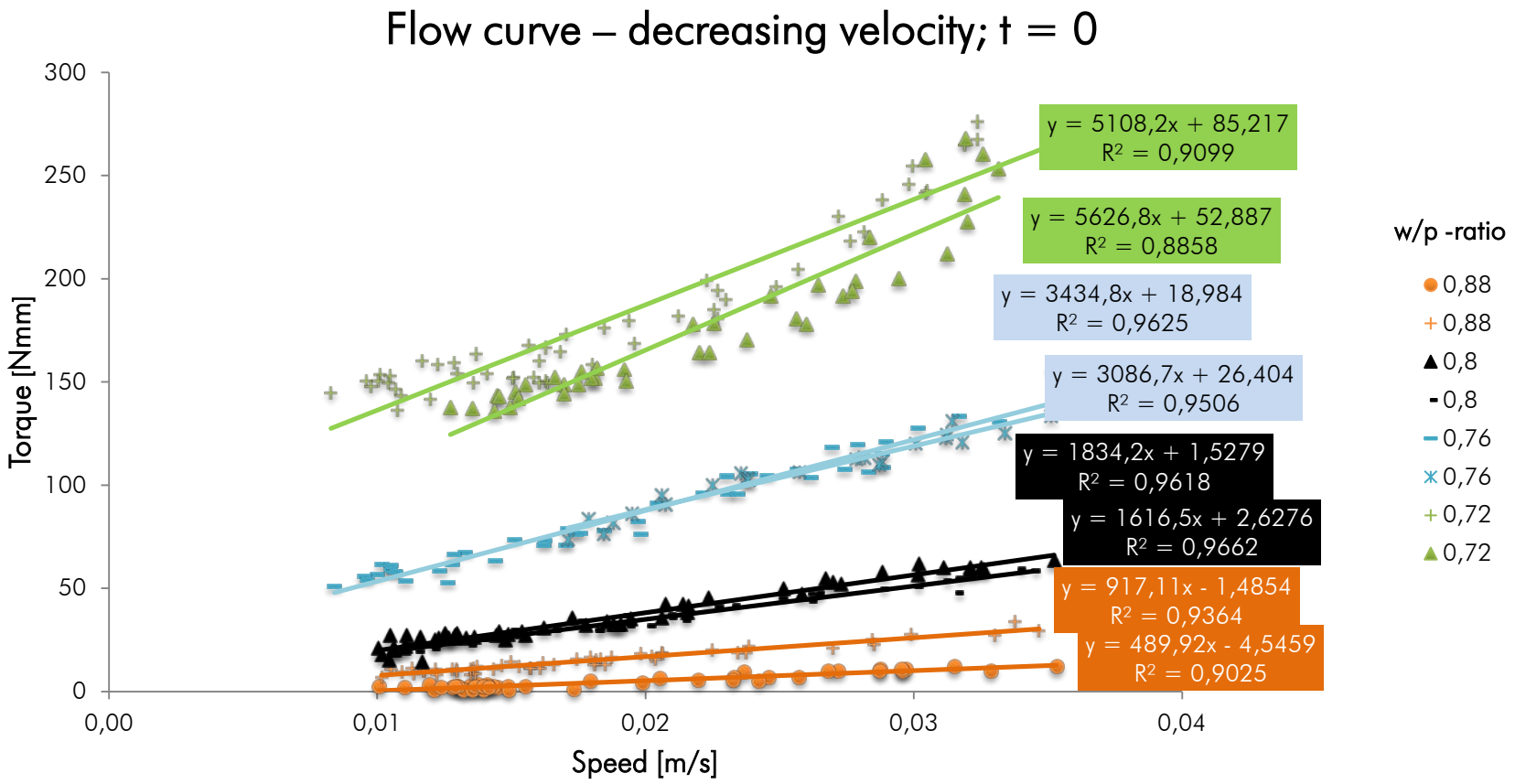
- Profile a



Test Results

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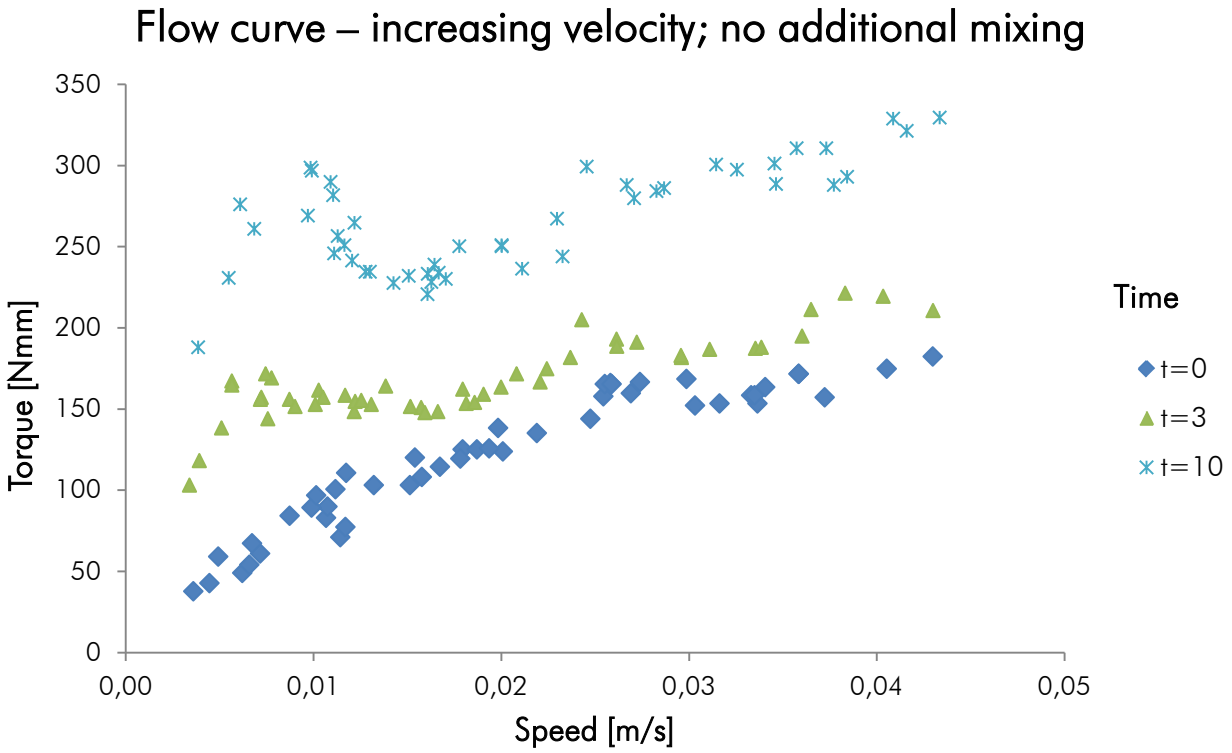
- Profile a



Test Results

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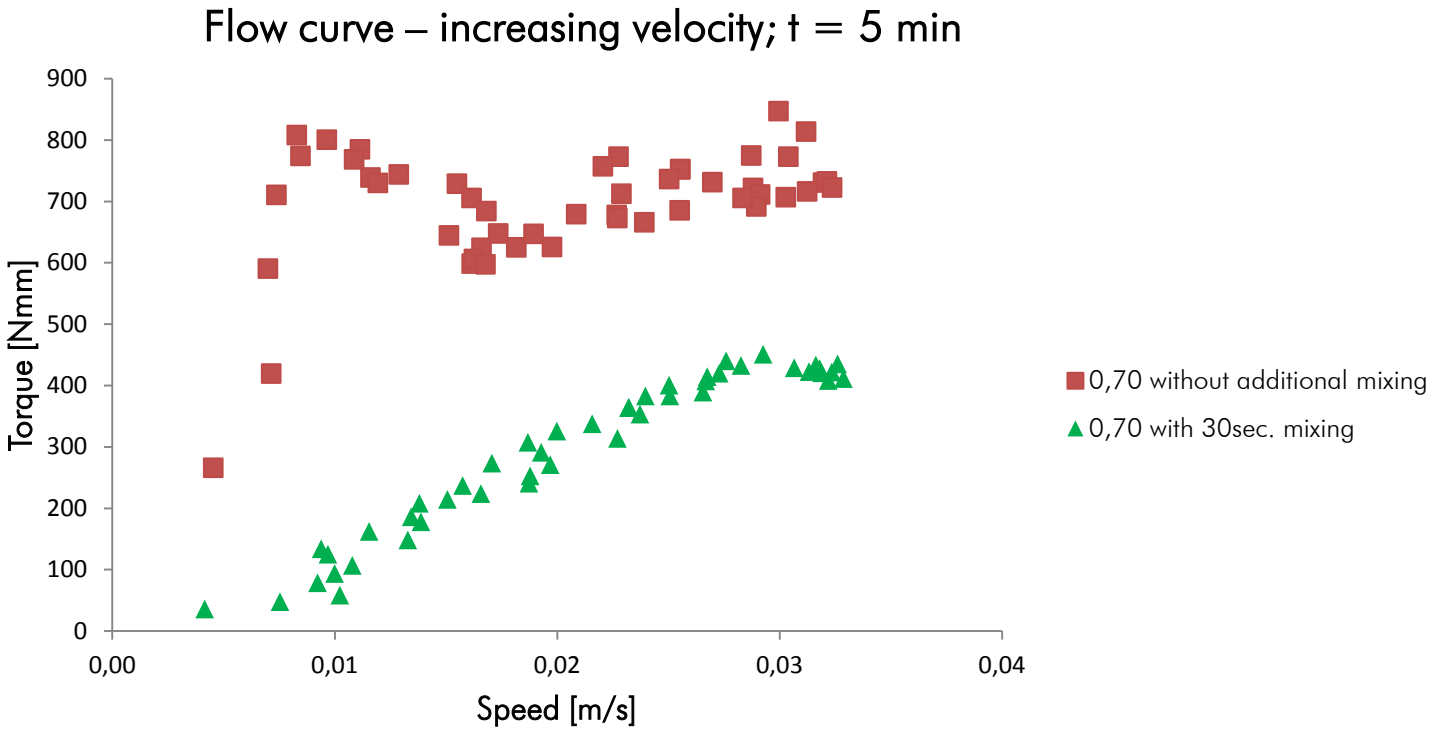
- Profile a



Test Results

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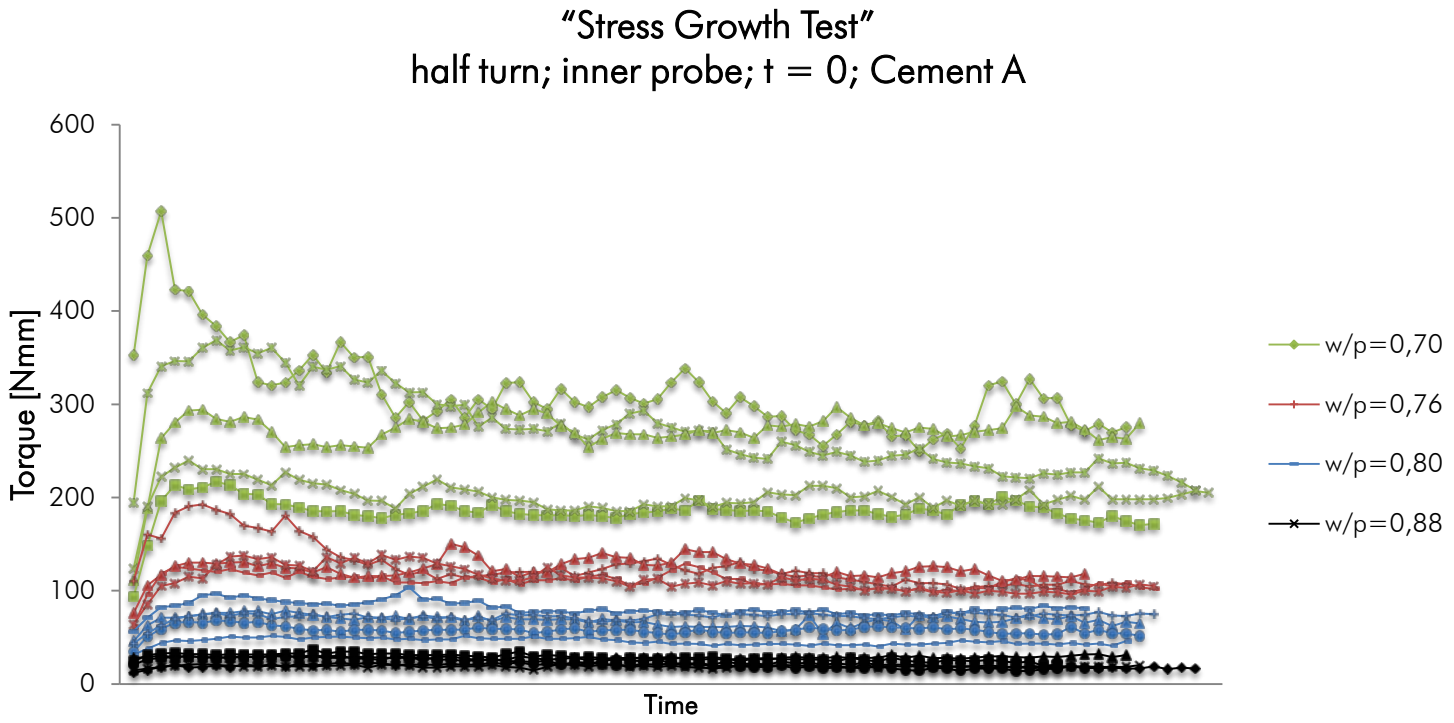
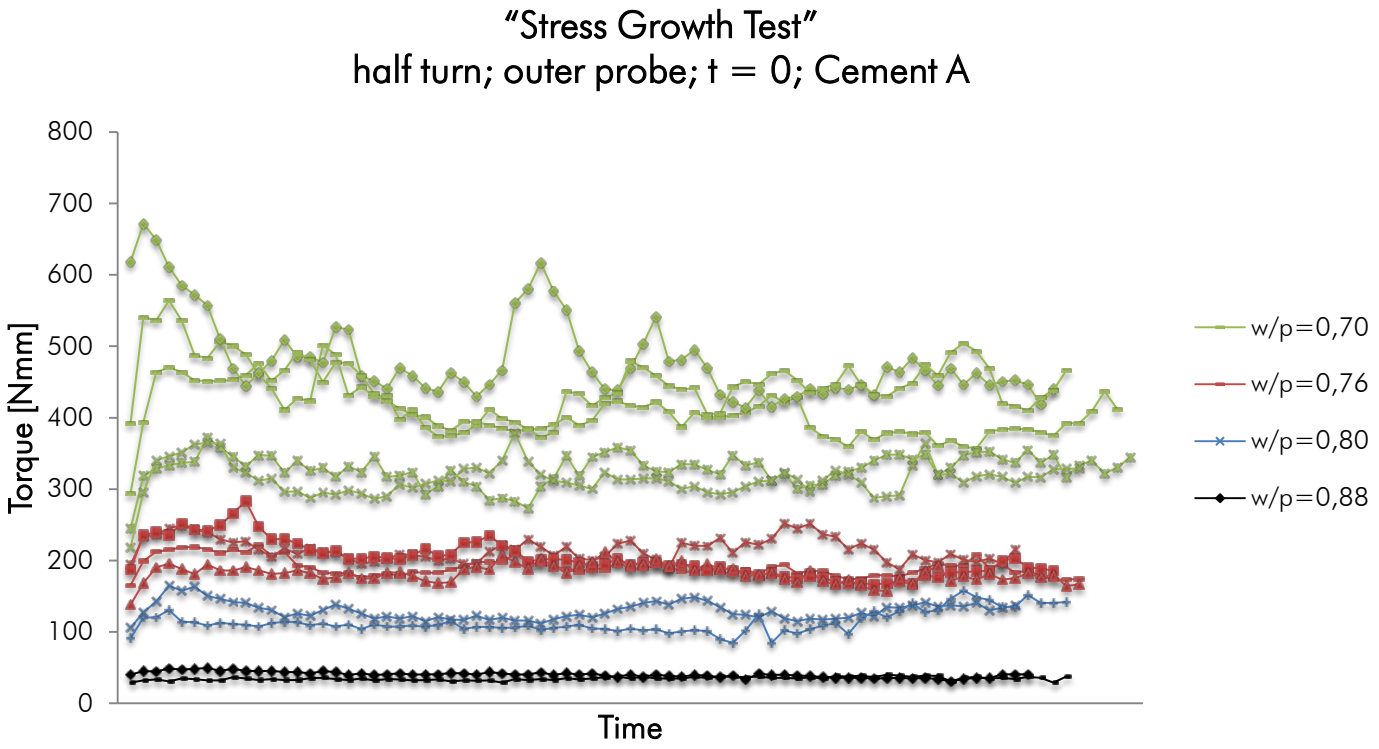
- Profile b



Test Results

HOCHSCHULE REGENSBURG UNIVERSITY OF APPLIED SCIENCES

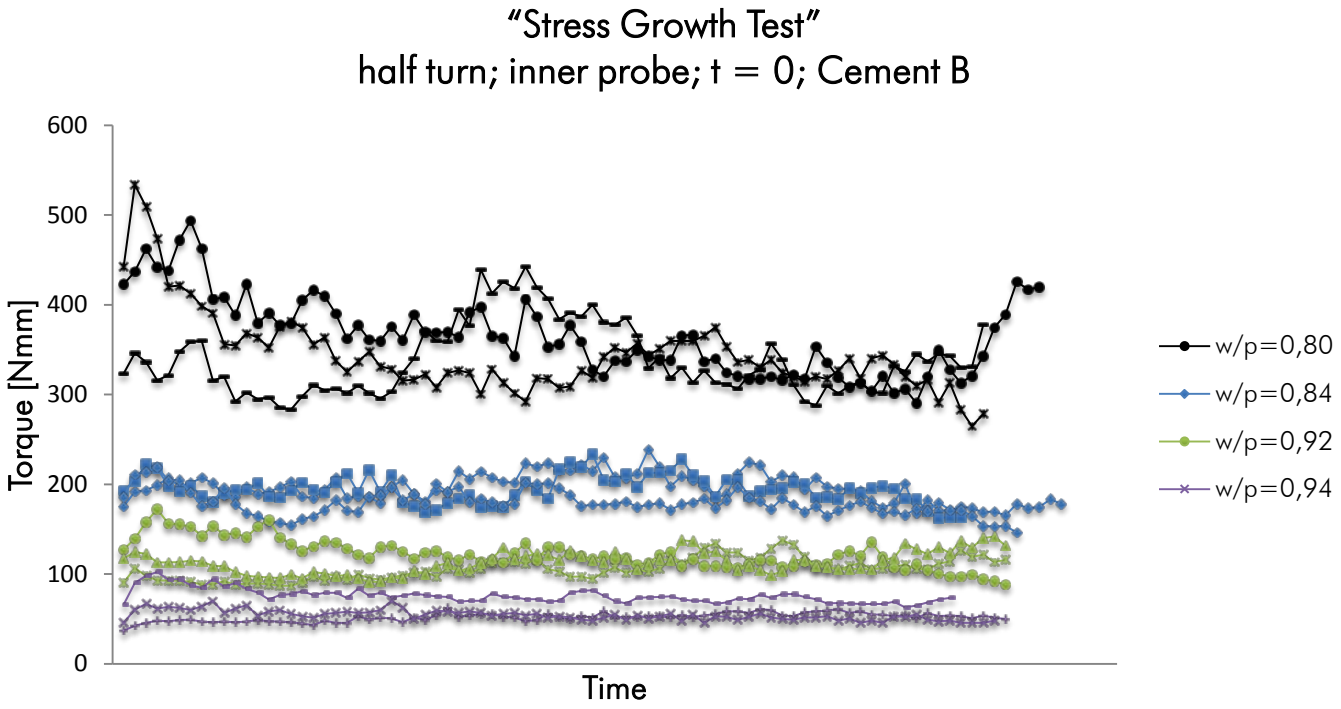
- Profile b



Test Results

HOCHSCHULE REGENSBURG UNIVERSITY OF APPLIED SCIENCES

- Profile b



Test Results

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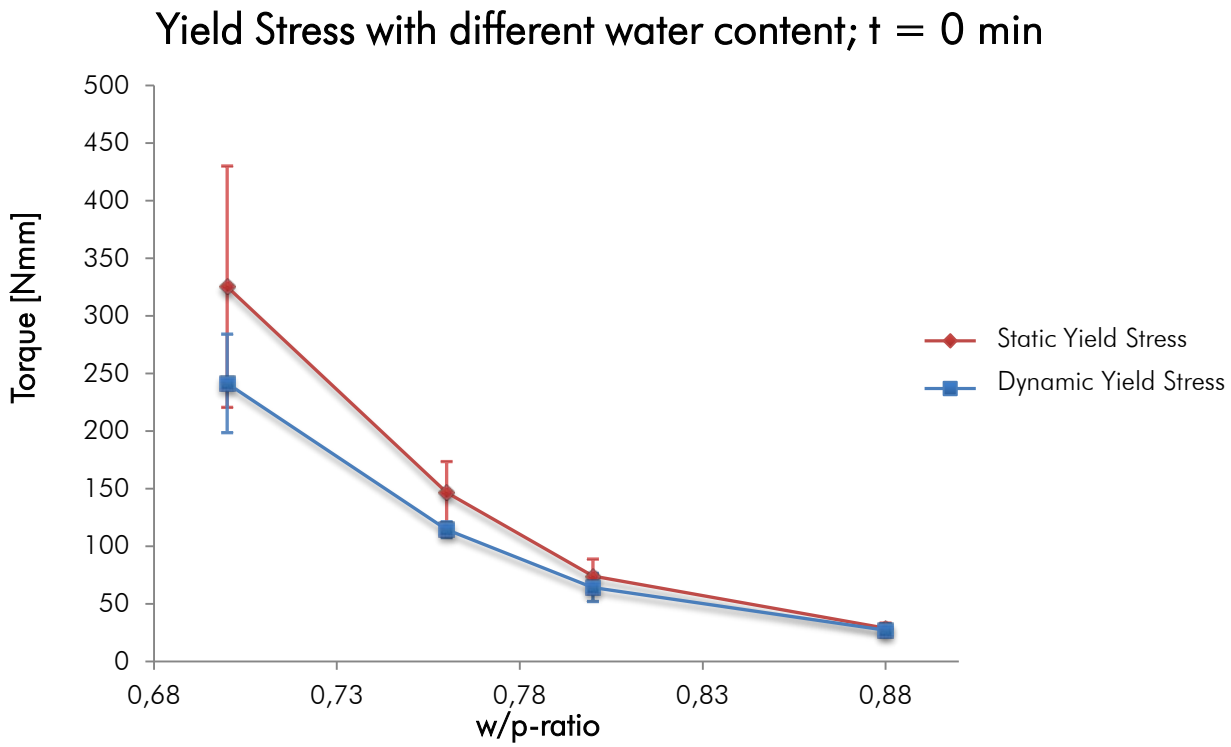
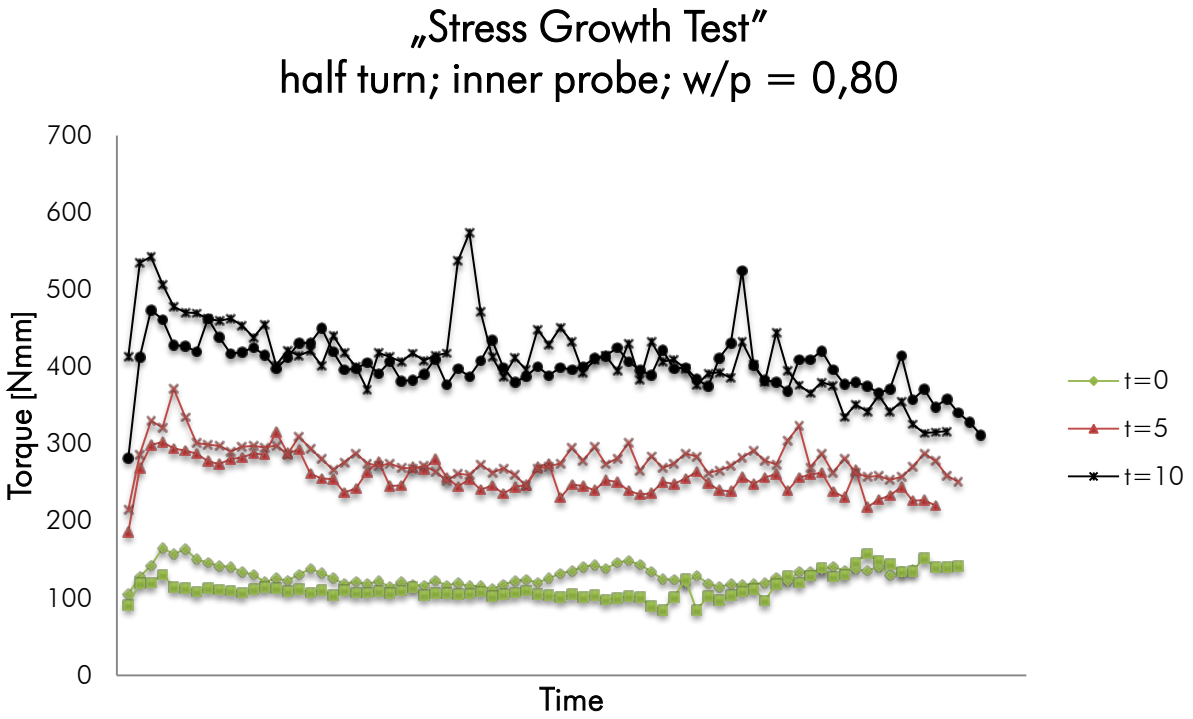
- Profile b (Mean of five measurements+ standard deviation)



Test Results

HOCHSCHULE REGENSBURG UNIVERSITY OF APPLIED SCIENCES

- Profile b



Test Results

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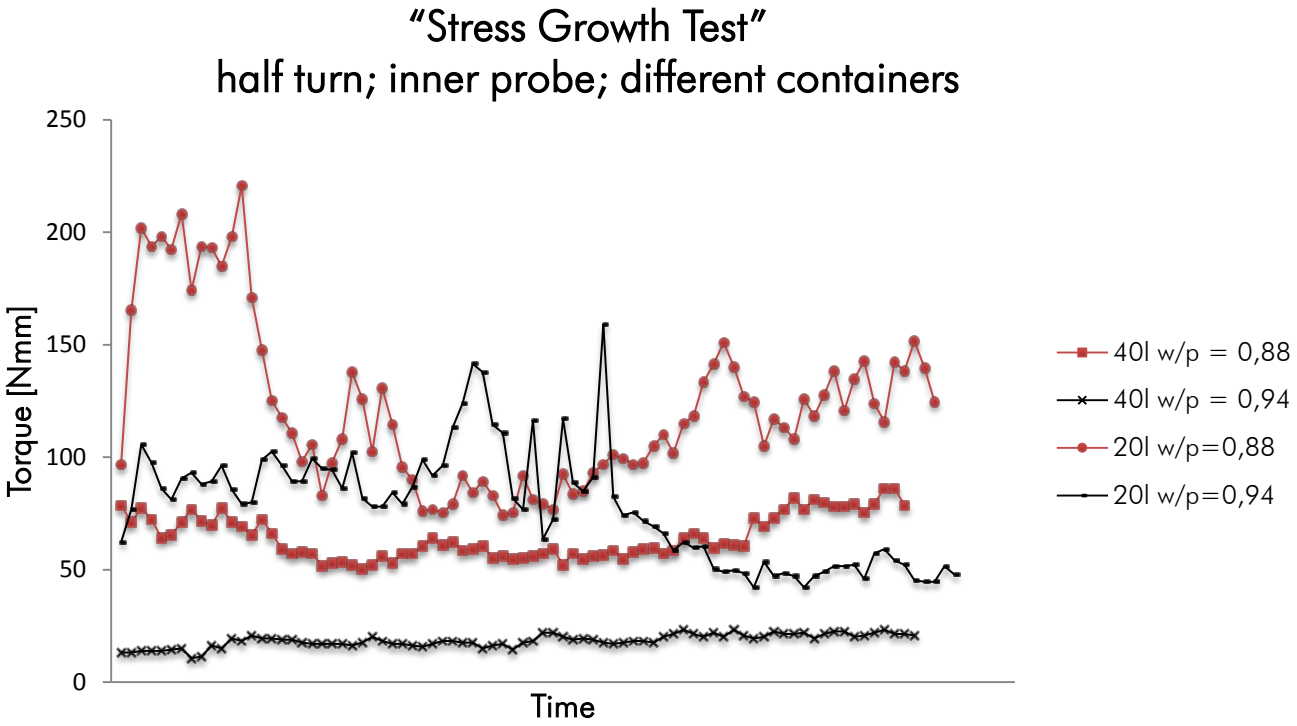
- 20 l container vs und 40 l container



Summary

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- More exact results with modified BT2
- No blocking of aggregates
- Flow curves with
  - structural build up and break down
  - relative Yield Stress and Plastic Viscosity
- Stress Growth Test (Torque vs. Time) with
  - dynamic Yield Stress
  - static Yield Stress
- Control of water content and flowability possible
- Further tests necessary

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Thank you !

Bild neuer BT2

Folgt noch! Noch auf Handy