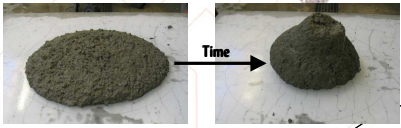


 **Time depending behaviour of cement pastes and mortar containing admixtures**




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11. 03. 2010


**Content**

- General
- Measurements
- PFI-theory
- Results



**General**

- Time-dependent behaviour: Change of properties with time
- Cement based materials (cement paste, mortar, concrete) show time-dependent behaviour
  - in fresh and harden state
- By adding water to cement, the change starts
  - Chemical reactions, particle interaction, ...
  - Hydration



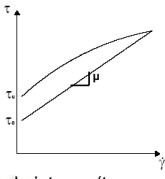
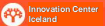
**General**

- Workability loss
  - Determined with simple slump flow test
    - ✓ Reduction of slump flow with time




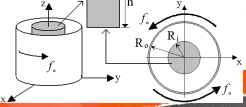


**General**

- Change of rheological properties in cement based systems with time:
  - (Static and dynamic) yield value
  - Plastic viscosity
  - Thixotropy
- Influenced by many factors:
  - Temperature, ...
  - Mix design: w/c-ratio, type of cement, admixtures (type and dosage), ...
  - ...

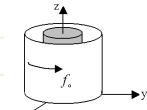
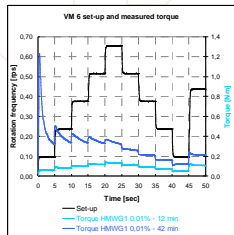



**Rheological Measurements**

- ConTec Viscometer 6 (for paste and mortar)
  - Coaxial cylinders viscometer
  - Stationary outer cylinder
  - Rotating inner cylinder
- Measurements:
  - 12, 42, 72 and 102 min after water addition
  - Cement paste completely at rest between measurements

## Rheological Measurements



### ConTec Viscometer 6 – set-up:

- Stepwise in- and decrease (loop-test) of rotation frequency ( $f_0$ )
- Duration of each step: 5 sec
- Duration of measurement: 50 sec

## PFI-Theory

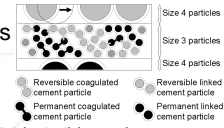
### Particle Flow Interaction - Theory

[J.E. Wallevik 2003 and 2009] , Software VVPF3.2

#### 2 time-dependent behaviours

##### Thixotropic behaviour:

- Reversible process
- reversible coagulated
- Particles are not permanent connected (total potential energy)
- Coagulation, dispersion and re-coagulation



##### Structural breakdown

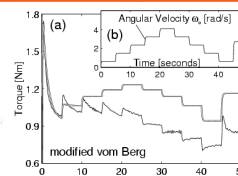
- Non-reversible process
- Reversible linked
- process of breaking certain linkages between cement particles, which were assumed to be formed by the hydration processes

## PFI-Theory

### PFI + Material Parameters [J.E. Wallevik 2003 and 2009]

- Material parameters are not directly observable
- For finding the parameters of this complex model, a certain automatic parameter identification (API) algorithm is applied.
- Parameter restrictions are needed, different for each mix or measurement
  - ✓ For blank mix (no ST) and with ST CS1 0,2%
  - ✓ ST mixes with HMWG1, test at 12 min
  - ✓ ST mixes with HMWG1, tests at 42, 72 and 102 min

## PFI-Theory



## Material - Stabilizer

### EN 934-2: Stabilizer (ST)

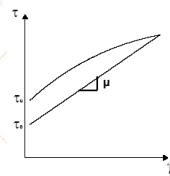
An admixture (for cement/concrete) which reduces the loss of water by a reduction of bleeding

#### Also known as:

- Viscosity enhancing agent/admixture (VEA)
- Viscosity modifying agent (VMA)

#### Influence of ST on:

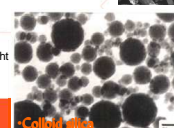
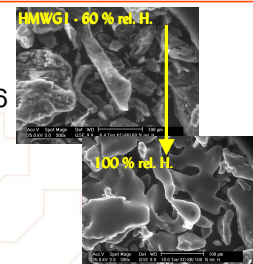
- (Plastic) viscosity
- Dynamic and static yield stress
- Thixotropy
- Workability

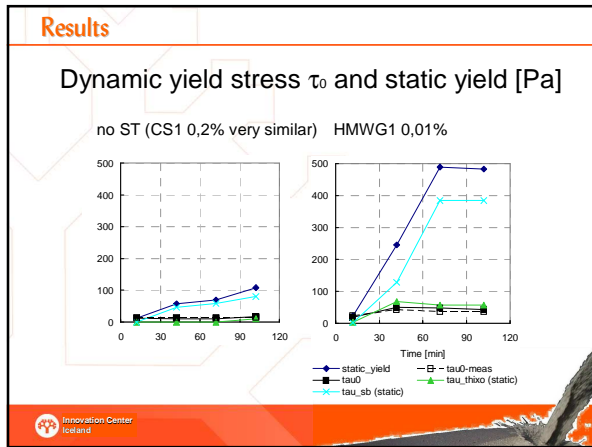
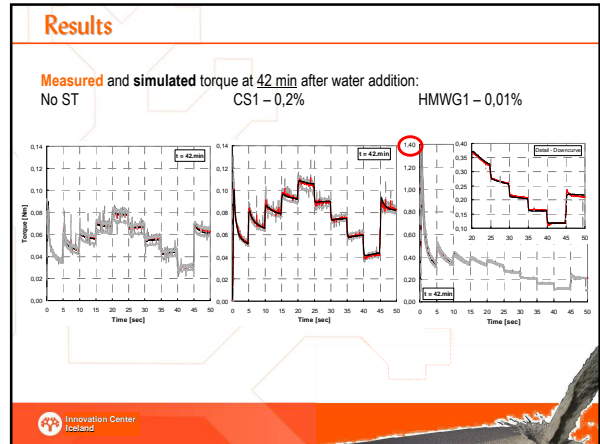
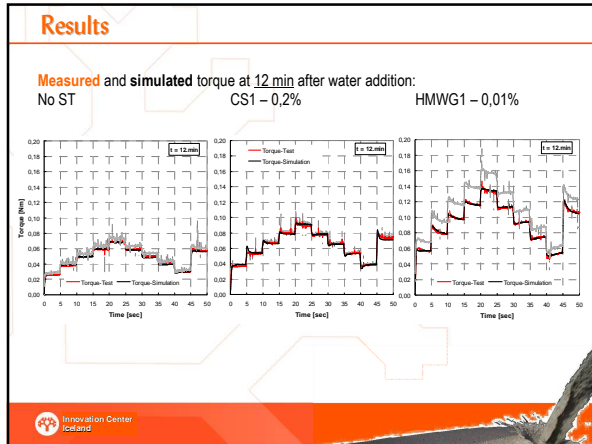


## Materials

- Cement:
  - CEM I 52,5 N
- Water/cement-ratio: 0,36
- Super plasticizer (PC):
  - carboxylic ether
  - 0,15 %\*
- Stabilizer (ST):
  - No ST
  - High molecular weight biopolymer HMWG1 0.01%\*
  - Amorphous, colloid silica CS1 0,2%\*

\* Dry content of material in w.-% of cement weight





- ### Conclusions
- Cement pastes without and with addition of 2 different stabilizers:
    - HMWG1 - based on a high molecular weight polysaccharide derivative
    - CS1, which is based on colloid silica. % stabilizer based on a high molecular weight polysaccharide derivative.
  - Pastes containing ST HMWG1 shows significant higher static yield value and plastic viscosity.
  - For all cases, most of the static yield value is attributed to structural breakdown meaning that it can be reduced by the re-agitation.
  - However, true thixotropic behavior gives a relatively small contribution to the static yield value in all cement pastes.
  - Applying the PFI-Theory showed a very good fitting of measured and simulated torque values
- Innovation Center Iceland

### Time depending behaviour of cement pastes and mortar containing admixtures

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