Concrete research needs in the future

Short over-view

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13.3.2024

Approach

- General view of the recognized research need, not based on the presentation of today
- Broader, practical topics, not going in details
- No solutions are given, just the topics needing research
- Several research needs are connected to others
- Not in order of importance

Contents

- Binders
- Aggregates
- Admixtures
- Concrete production
- Quality assurance and testing of concrete and concrete structures

Present situation -> Research needs

Binders

Present situation:

a) Very strong pressure to reduce CO_2-emissions of cements

b) Decreasing availability of effective SCMs

Binders

Research needs:

1) Reducing of CO_2-emissions of (portland) cement production
   - Raw materials and energy efficiency
   - Carbon Capture and Storage/Utilization
2) Increasing the use present and new SCMs
   - New blended/composite cements
   - Various ways to use SCMs
3) Development of new non-$CaCO_3$-based cements

Aggregates

Present situation:

a) Moving from naturally graded to crushed aggregates (also fine aggregate)

b) Water demand of aggregate is on relatively high level

c) Increasing use of recycled aggregates

d) Transportation of aggregates causes high CO_2-emissions

EFFECT OF WATER DEMAND

- **Water requirement of 180 vs 160 dm^3/m^3**
- **If w/c = 0,40**
- **180 dm^3/m^3 requires cement 450 kg/m^3**
- **160 dm^3/m^3 requires cement 400 kg/m^3**

Affects:

- **CO_2-emission**
- **Max temperature**
- **Costs**

Aggregates

Research needs:

1) Improvements in aggregate quality
   - Reducing the water demand
   - Reducing the natural quality variation
2) Increasing use of crushed fine aggregates without increasing the water demand
3) Development of small scale production of crushed aggregate
4) Development of use of recycled aggregates

Admixtures

Present situation:

a) New low-carbon binders / concretes need new admixtures

b) Present concretes are rather sensitive, are admixture increasing or reducing the sensitivity?

Admixtures

Research needs:

1) Development of admixtures of low-carbon concrete
   - Accelerators
   - Water-reducing admixtures
   - Air-entraining agents
2) Development of special admixtures for binders with low clinker contents
   - Chemical activators
3) Development of admixtures for improving robustness of concrete

Concrete production

Present situation:

a) Reduction of CO_2-emissions causes challenges in concrete production

b) Challenges with hydration temperatures (max, diff)

c) Some processes poorly controlled, e.g. compaction, curing

d) Level of automatization in concrete construction is on low level, new production methods, e.g. 3D-printing, wait break-through

Concrete production

Research needs:

1) Development of use of low-carbon concretes
   - Strength development, utilization of heat curing and admixtures
   - Durability properties
2) Other possibilities to reduce CO_2-emissions of concrete
3) Managing the hydration temperatures
   - Effects of elevated temperatures, updated limit values
   - Concrete with lower heat development
   - Cooling systems, control of temperatures
4) Development of automatization, development of new production techniques (esp. pre-casting)

Quality assurance and testing

Present situation:

a) High variation in concrete properties. Variation caused by raw materials. Also manufacturing processes cause variation.

b) QC testing methods are labour intensive and operator sensitive, testing frequency is (very) low

c) Test methods for durability properties (e.g. freeze-thaw) are relatively poor (long-lasting tests, high variation in results)

Quality assurance

Research needs:

1) Development of automated test methods for fresh concrete properties (consistency, air content and w/c-ratio). Both at mixing station and in concrete truck at construction site.
2) Methods for controlling compaction of concrete
3) Development of more advanced test methods for durability properties of concrete
4) Development of NDT-methods

Thank you

Thank You, Anna

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