Industrial PhD project

Concrete without Portland cement

Marvin Glissner

About me

BSc civil engineering GER

MSc civil engineering DK/GL/NO

Industrial PhD DK

Contractor On-site

Const. chemicals Mainly R&D

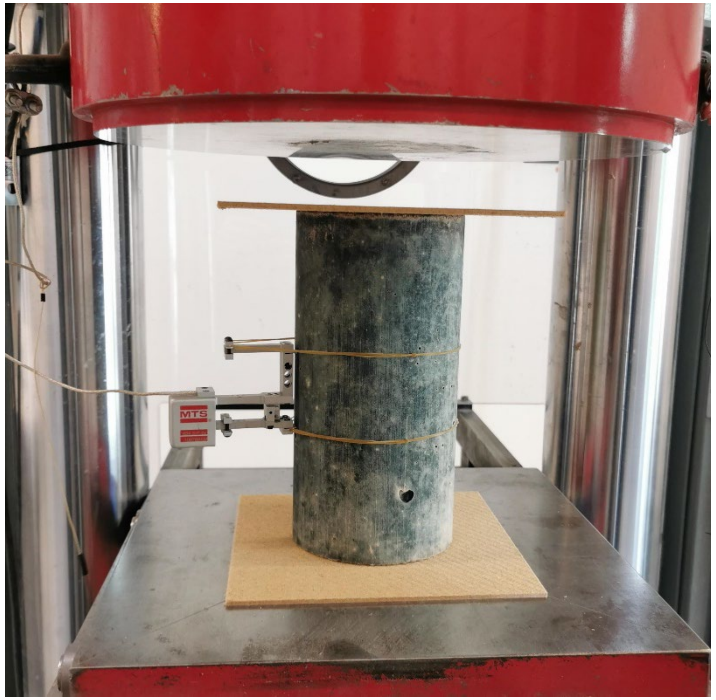
COWI engineering

Project setup

Project Objectives

For a range of selected alkali activated materials, AAM:

- Study material properties
- Use experimental data for investigation
- Link material properties to structural behavior



What is AAM

Aluminosilicate Powder

Activator

Water

AAM paste

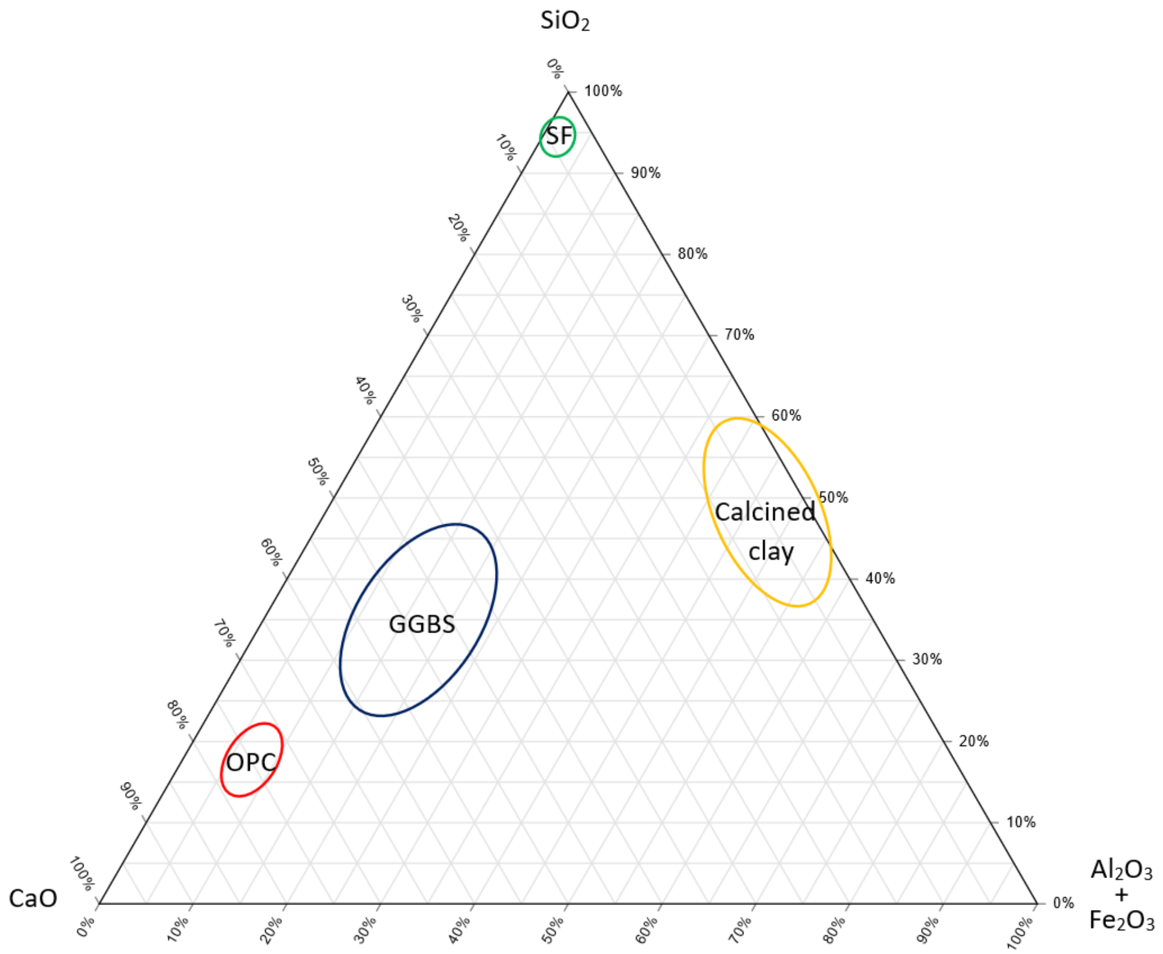
What is AAM

Examples

- Calcined clay
- Slag
- Fly ash

Reaction products

- CSH and/or CASH and/or NASH
- Varying in structure



Why now?

- Less CO_2 emission
- Less energy consumption
- Better performance “sometimes”

- Admixture technology has advanced
- Control of mix conditions has advanced

History of AAM

Germany 1908 patented

- Alkali activated slag
- “fully equal to the best Portland cements”

Britain 1940

- 30 slags
- ”enhanced tensile & flexural strength compared to OPC”
- ”low heat evolution”

History of AAM

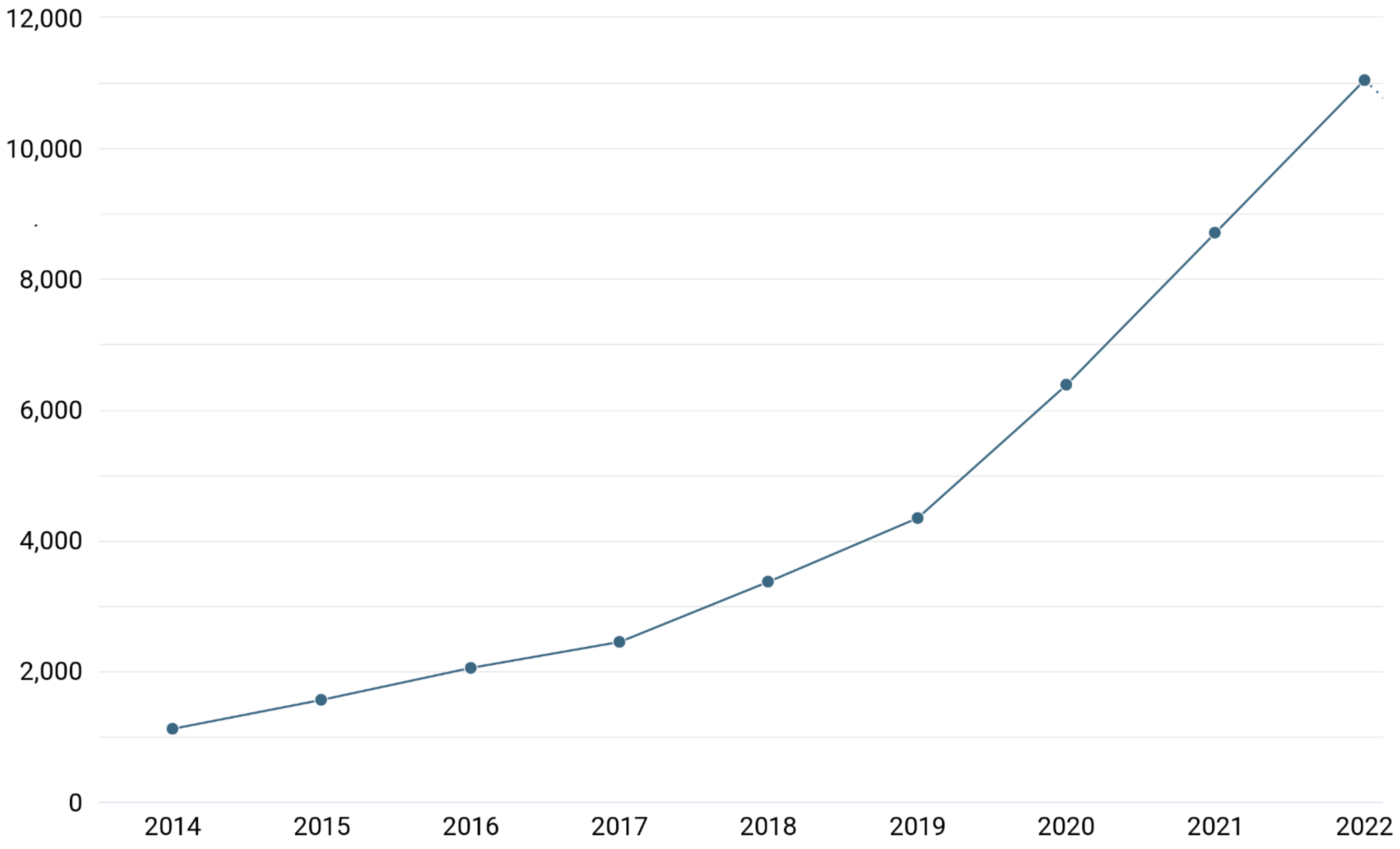
AAM

- Workability issues
- Sensitivity to activation conditions
- Caustic materials

OPC

- Less sensitive
- Cheap
- Good performance

Trend “Geopolymer” publications



Why?

- Green transition
- Missing knowledge – not codified
- Claim of better performance
- Use unutilized materials

Cases of use

Energy & environment

May 2023

Record-breaking pour of Earth Friendly Concrete complete at London Power Tunnels project

Cases of use

National Grid and its contractor HOCHTIEF-MURPHY Joint Venture (HMJV) have completed the world's largest ever continuous pour of Earth Friendly Concrete® at London Power Tunnels, a £1bn project to rewire London.

736m3, or 736,000 litres (enough to fill around two 25m swimming pools) of more sustainable, cement-free concrete was poured to fill the base of the 55m deep tunnel drive shaft at National Grid's Hurst Substation in South London. The cement free solution was developed by Wagners and supplied by Capital Concrete and uses a binder of ground granulated blast furnace slag and fly ash geopolymer concrete system chemically activated by the use of industrial waste products instead of cement. **The concrete reduces carbon by around 64%, saving an estimated 111kg of CO_2 per cubic metre poured in comparison to concrete that would have traditionally been used.**

The use of Earth Friendly Concrete was driven forward by a team of young engineers on the project and supported by HMJV's engineering experts and AECOM, Mott MacDonald and WSP, following several trials at different London Power Tunnels sites.

The record-breaking pour on Earth Day (22 April) at National Grid's Hurst substation site was needed to infill the base of the 55m deep tunnel shaft to its permanent level, following the successful completion of 9.2km of tunnelling over 2 tunnel drives from Hurst to Eltham and Crayford.

Cases of use


next beton
Kontaktieren Sie uns
MENÜ
100% ZEM
MADE IN G
Bis zu
70%
weniger CO_2
XA3
konform
100%
zementfrei

Cases of use: DK!

IBF A/S: Geoprime® solution used in sewage pipes in Denmark saves over 50% CO_2

Project WP

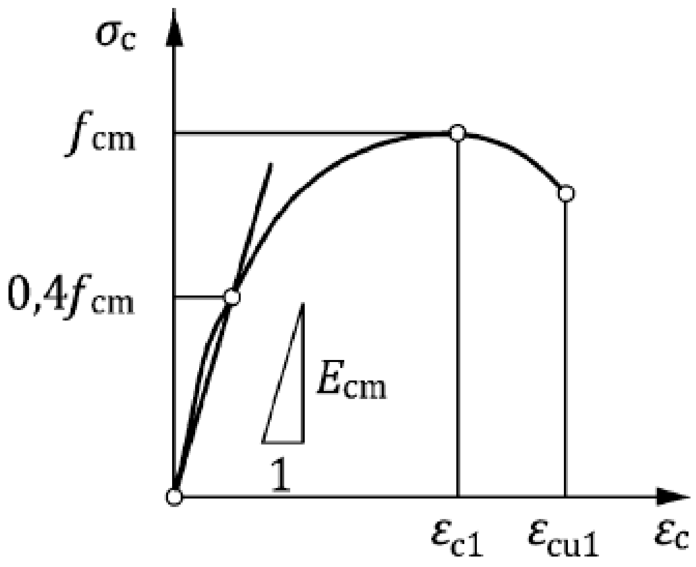
- Literature review
- Micro- and meso level properties
- Macro level structural properties
- Modelling and analysis

Micro- and meso-level properties

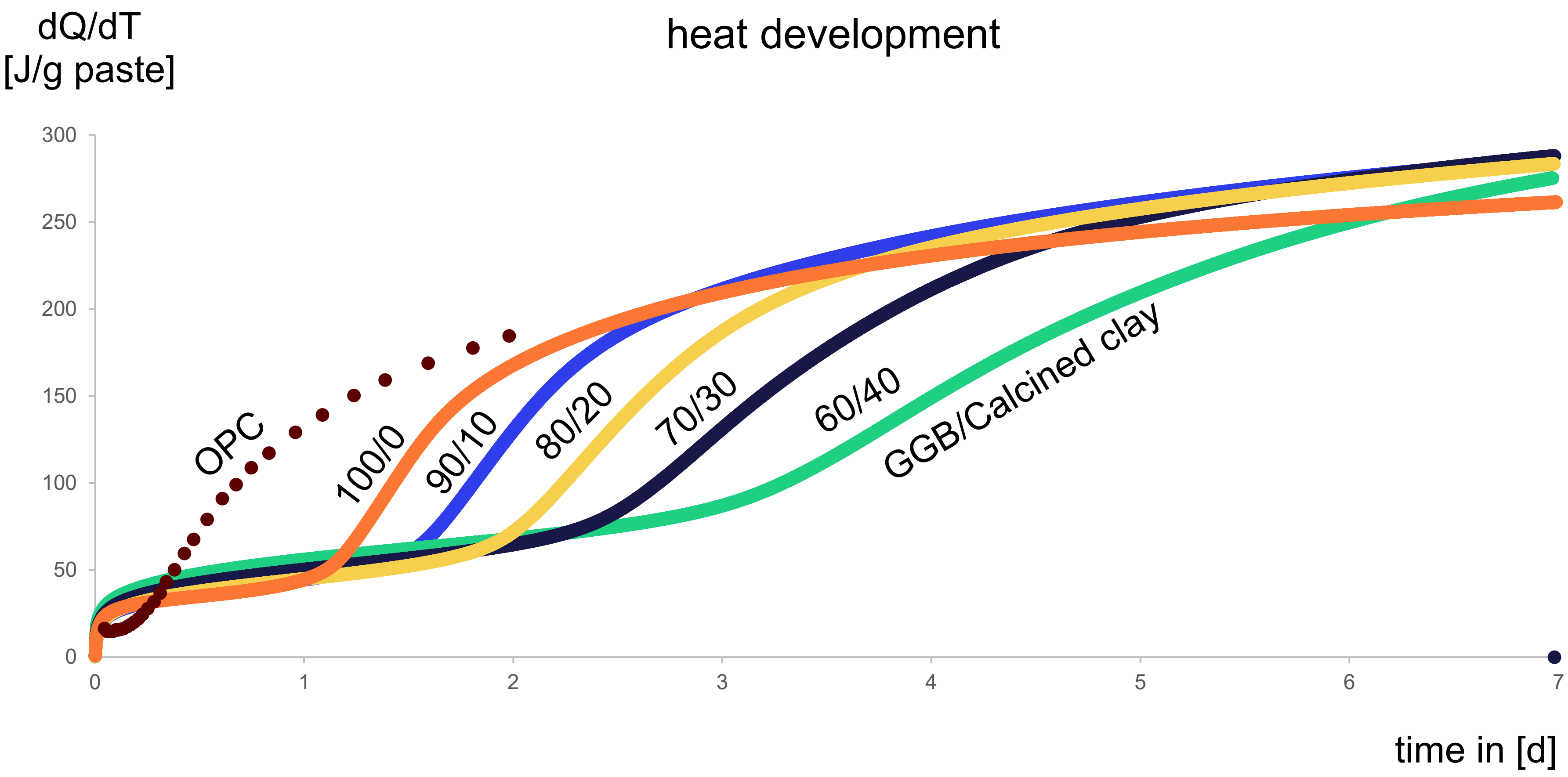
- Reference mix
- AAM concretes

- Properties for model input

- Other relevant properties



Other relevant properties

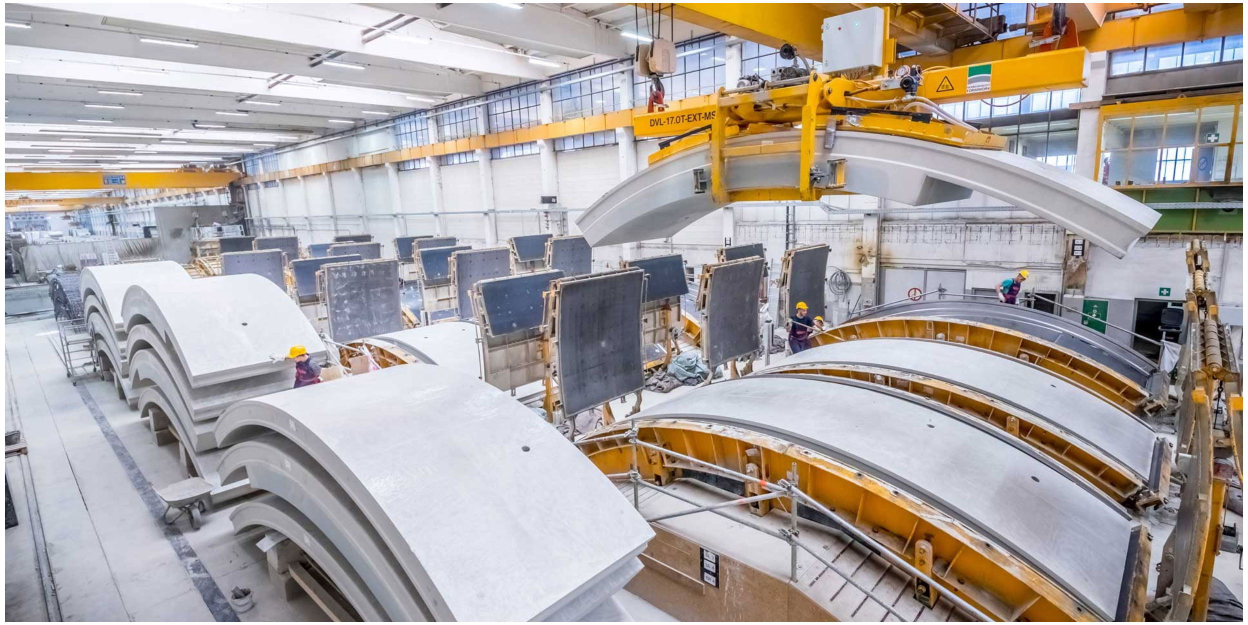


Structural properties

Large scale testing

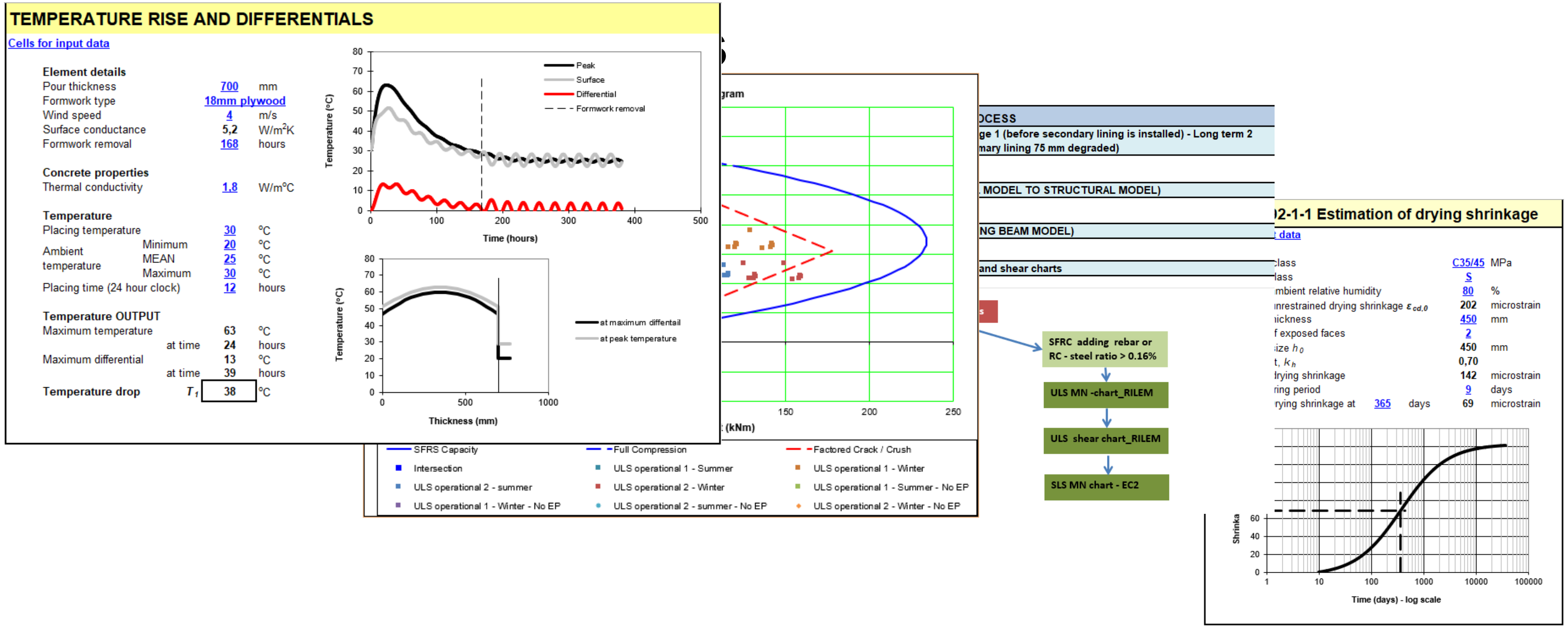
- Reference
- AAM concretes

- Uncover differences
- Provide data for verification



DTU

COWI



TEMPERATURE RISE AND DIFFERENTIALS
Cells for input data
Element details
Pour thickness 700 mm
Formwork type 18mm plywood
Wind speed 4 m/s
Surface conductance 5,2 W/m²K
Formwork removal 168 hours
Concrete properties
Thermal conductivity 1,8 W/m°C
Temperature
Placing temperature 30 °C
Ambient temperature Minimum 20 °C
MEAN 25 °C
Maximum 30 °C
Placing time (24 hour clock) 12 hours
Temperature OUTPUT
Maximum temperature 63 °C
at time 24 hours
Maximum differential 13 °C
at time 39 hours
Temperature drop T1 38 °C
Peak
Surface
Differential
Formwork removal
Temperature (°C)
Time (hours)
at maximum diffentail
at peak temperature
Thickness (mm)
gram
(kNm)
SFRS Capacity
Full Compression
Factored Crack / Crush
Intersection
ULS operational 1 - Summer
ULS operational 1 - Winter
ULS operational 2 - summer
ULS operational 2 - Winter
ULS operational 1 - Summer - No EP
ULS operational 1 - Winter - No EP
ULS operational 2 - summer - No EP
ULS operational 2 - Winter - No EP
OCESS
ge 1 (before secondary lining is installed) - Long term 2
mary lining 75 mm degraded)
MODEL TO STRUCTURAL MODEL)
NG BEAM MODEL)
and shear charts
SFRC adding rebar or RC - steel ratio > 0.16%
ULS MN -chart_RILEM
ULS shear chart_RILEM
SLS MN chart - EC2
)2-1-1 Estimation of drying shrinkage
data
lass C35/45 MPa
lass S
mbient relative humidity 80 %
nrestrained drying shrinkage ε cd,0 202 microstrain
ickness 450 mm
f exposed faces 2
ize h0 450 mm
t, kh 0,70
rying shrinkage 142 microstrain
ring period 9 days
rying shrinkage at 365 days 69 microstrain
Shrinka
Time (days) - log scale

Thank you for your attention

Feel free to contact me

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Sources

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