## Mock-up for Verification of Input Parameters for Temperature and Stress Calculations

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### Large Concrete Structures:

- Heat development from the hardening process
- Large temperature differences
- Tensile stresses may exceed strength of concrete
- Risk of thermal cracks



Thermal cracks in top of restrained wall



Thermal cracks in wall cast on existing structure



## How to avoid thermal cracking:



• Temperature and stress calculations for optimizing the casting process

## Tools for optimizing the casting process:

- Concrete with low heat development
- Cooling pipes
- Heating wires
- Heating mats
- Surface protection (formwork, insolation)





## Are the results of the Temperature and stress calculations reliable?

Questions have been raised regarding:

- Effect of cooling pipes (steel/plastic/flow rate of water)
- Effect of heating mats and heating wires
- Insulating capacity of formwork systems and insulation materials





Mock-up for Verification of Input Parameters for Temperature and Stress Calculations



- Test implication of:
  - Type of cooling pipes (steel, plastic)
  - Flow rate / temperature of cooling water
  - Heating wires & heating mats
  - Insulation materials



# The Mock-up Design



- L x W x H : 0.6 x 1.2 x 6.45 m
- Heating wires (red symbols)
- Steel cooling pipes (dark blue symbols)
- Plastic cooling pipes (light blue symbols)
- Insulation: 300 mm EPS + 150 mm EPS on top.



## The Mock-up Design

#### 44 Thermo Couples:

- 38 at the centre
- 3 at a distance of 500 mm from each end







## The Mock-up Construction process





## The Mock-up Construction process





### The Mock-up



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Equipment for measuring and controlling the flow rate of the cooling water

Chiller unit Steel cooling pipes -Plastic cooling pipes -

Thermo Couples for:

- inlet and outlet temperatures of the plastic cooling pipes
- inlet and outlet temperatures of the steel cooling pipes



## Impact of Heating Wires

Calculation with 4C Temp&Stress:

First calculation: 220 V

- Supplier's information: a voltage of 220 V
- Direct measurement: 200 V when two heating filaments are coupled to a 220 V outlet.



New calculation: 200 V



## Impact of Cooling Pipes



#### Polyethylene cooling pipes





hydrogen measurement measurements metrology mix design petrography renewable energy SCC SensoByg stress calculations temperature thermometry transport tribology