Effects of climate exposure on the (moisture) performance of structural details in timber bridges

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Introduction and objective

Durable Timber Bridges (DuraTB)

- This study is part of the european project DuraTB
- Overall objective of project:
  - ”To develop durable timber bridges with a given estimated technical lifetime”
- Durable timber bridges
  - *”The structure shall be designed such that deterioration over its design working life does not impair the performance of the structure below that intended, having due regard to its environment and the anticipated level of maintenance”* (EN 1990)

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Overall aim of this study

- To develop an exposure model for timber bridges to predict the material climate (MC;T) based on:
  - Local and global climate (RH; T; rain)
  - **Structural design (e.g. moisture traps or structural protection)**
  - Surface treatment
- The material climate can then be used in dose-response models together with material characteristics to estimate the risk of decay

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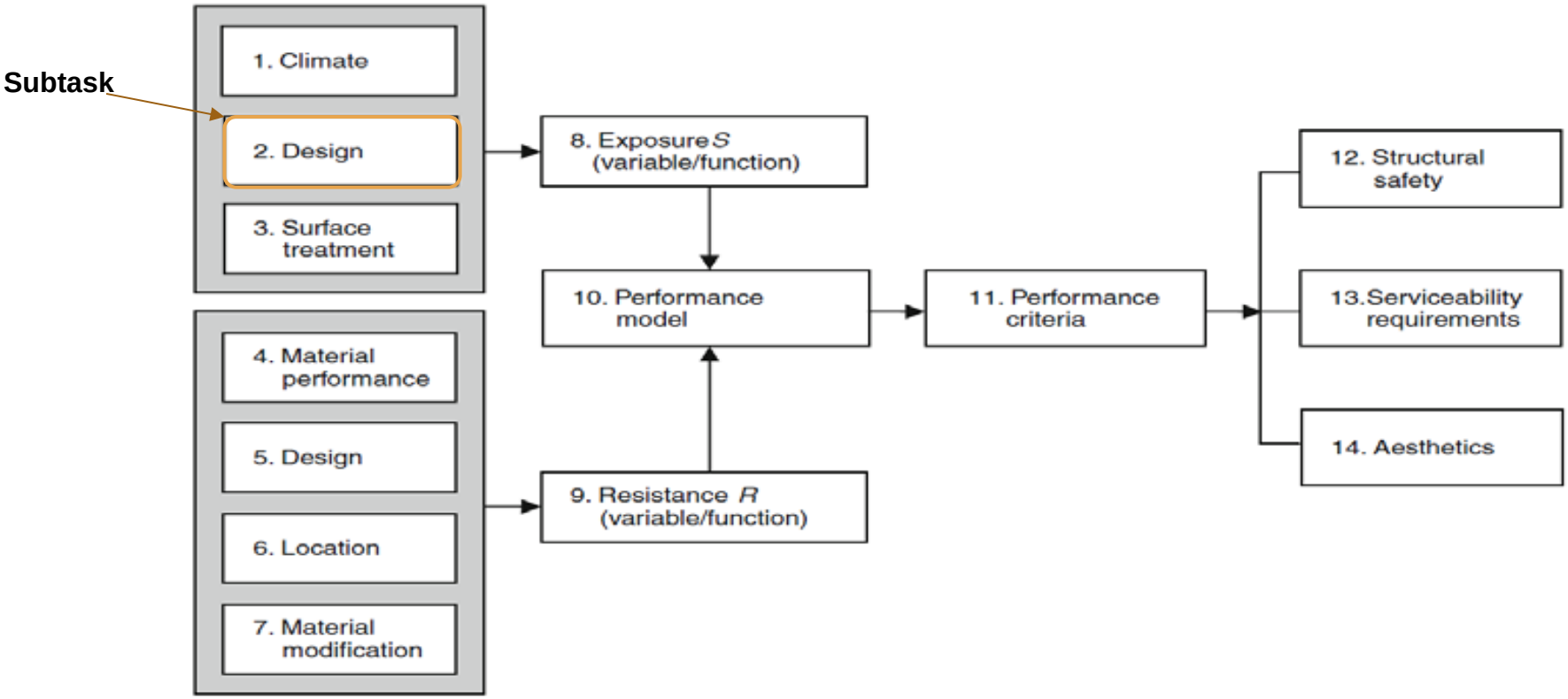
Performance model



- **Structural design (e.g. influence from moisture traps, structural protection)**

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Aim of subtask

- To evaluate the effect of detail design on the exposure (moisture content) in timber bridges.
  - Quantify the increased exposure due to moisture traps
  - Quantify the effectiveness (reduced exposure) of typical protective measures (e.g. cladding, horizontal cover)

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Test setup & measurements

Test setup

- Glulam beams and columns (untreated spruce) are exposed to natural climate over one year
- The specimens are designed with details relevant to the design of timber bridges e.g.:
  - horizontal/vertical contact areas, steel plates, column connection to ground etc…
  - protection in the form of cladding, horizontal protection etc…
- The moisture content is monitored by conductance-type moisture sensors

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Test site

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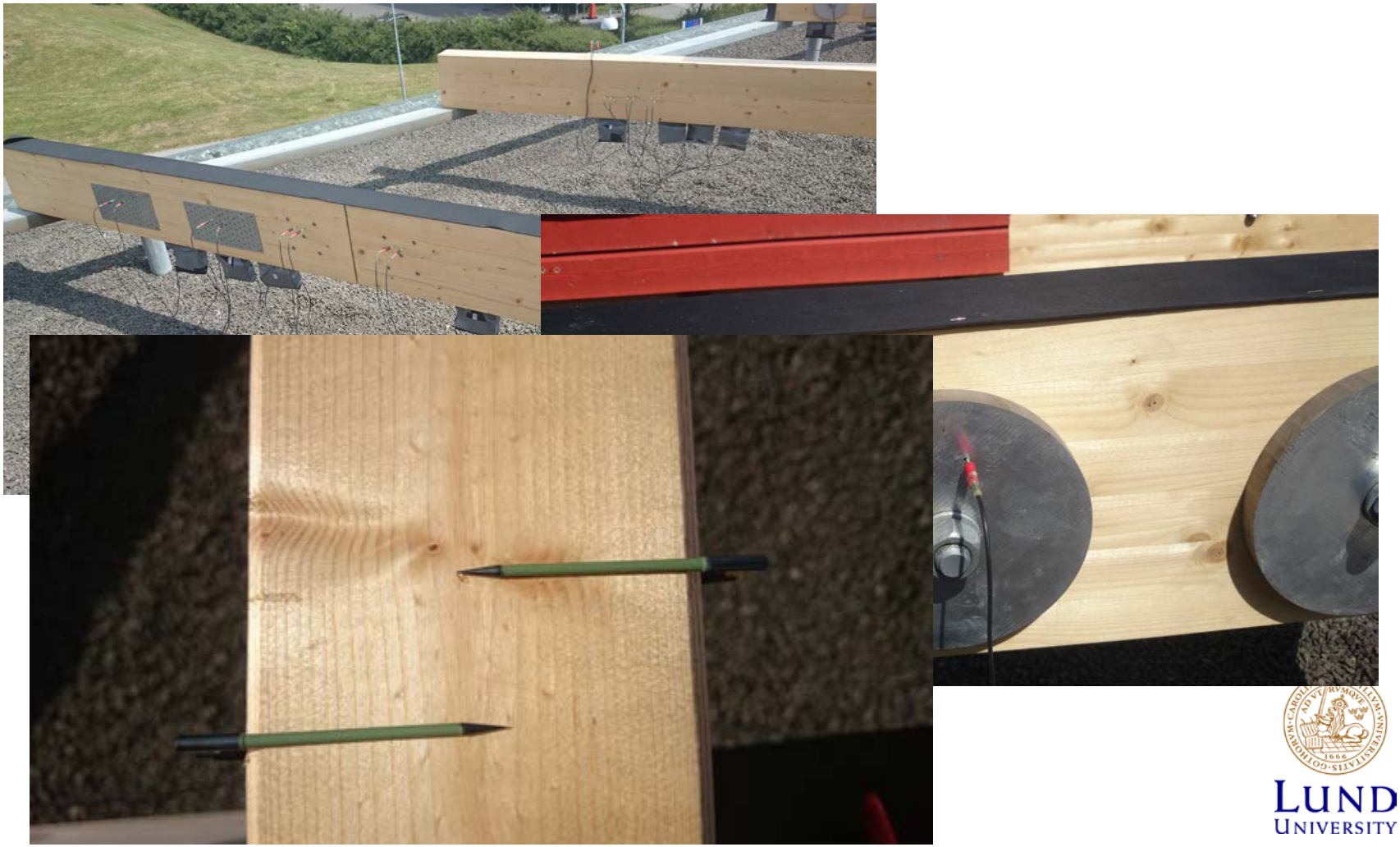
Test site



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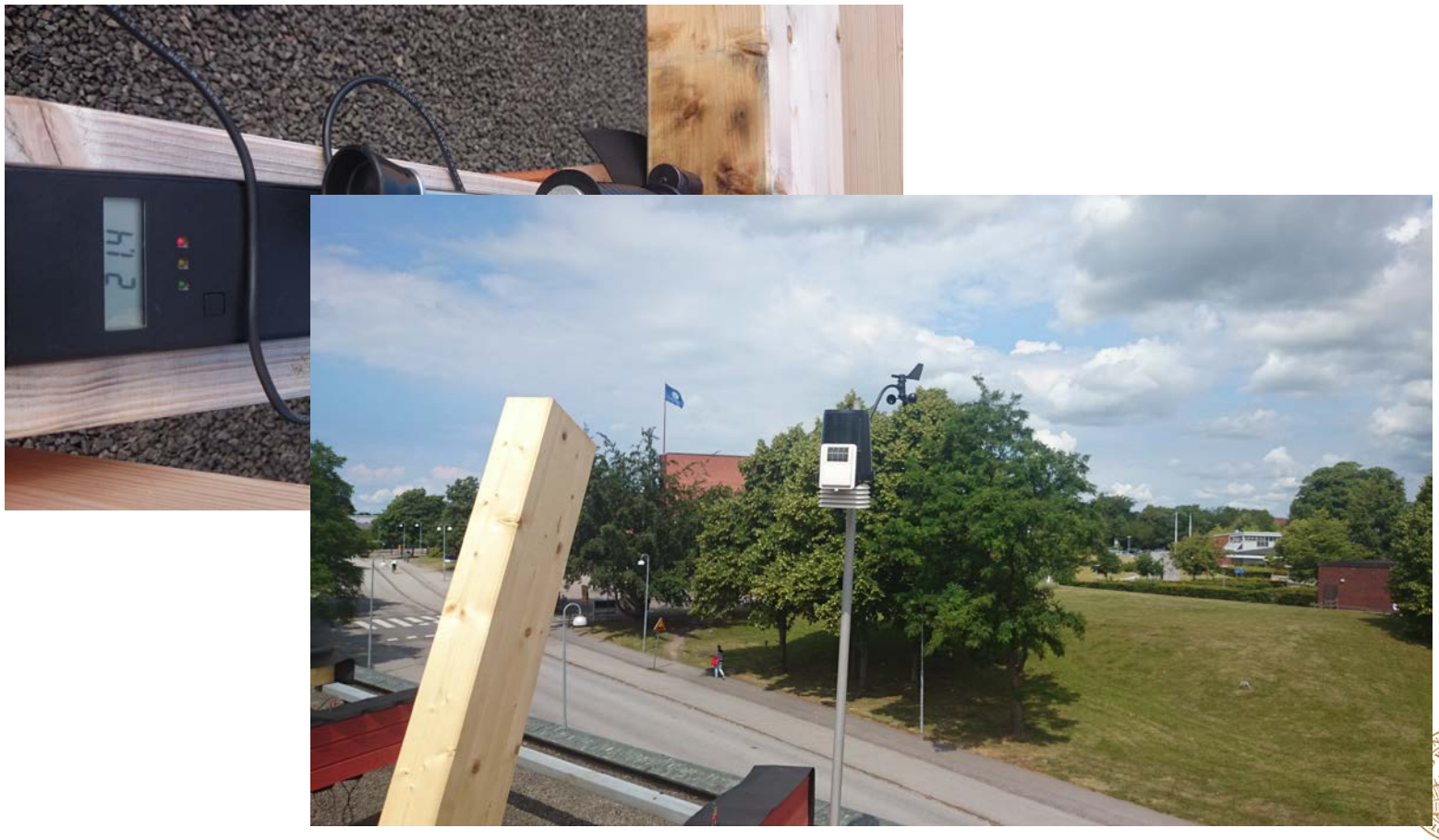
Measurements

- Moisture content is measured hourly in selected points by ~70 sensors (Type S-16 from Omnisense)
  - Pins are located 10-15 mm from the surface
- Some manual measurements are performed to check the validity of the measurements
- A weather station is recording RH,T,rain etc..

Measurements



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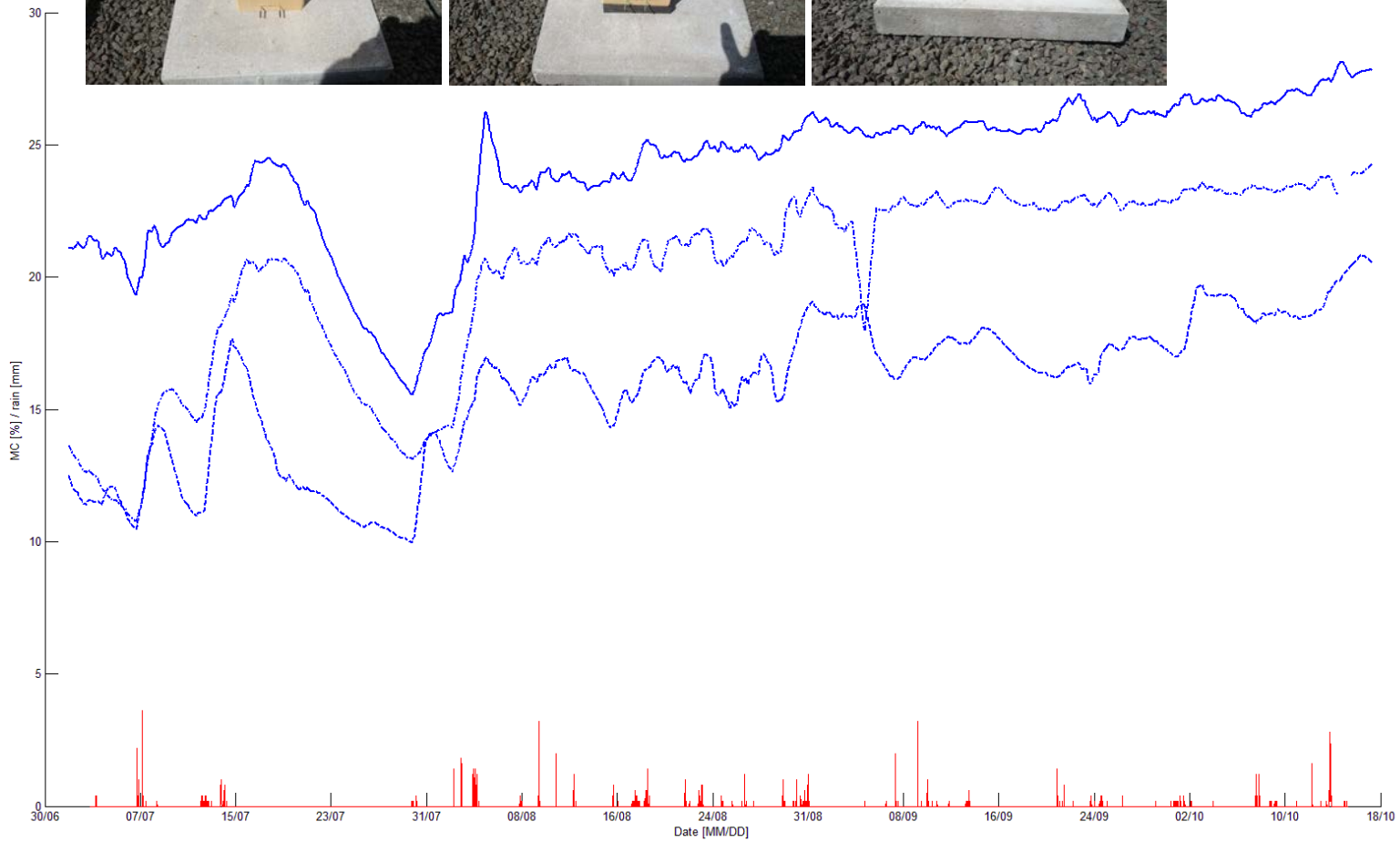
Preliminary results

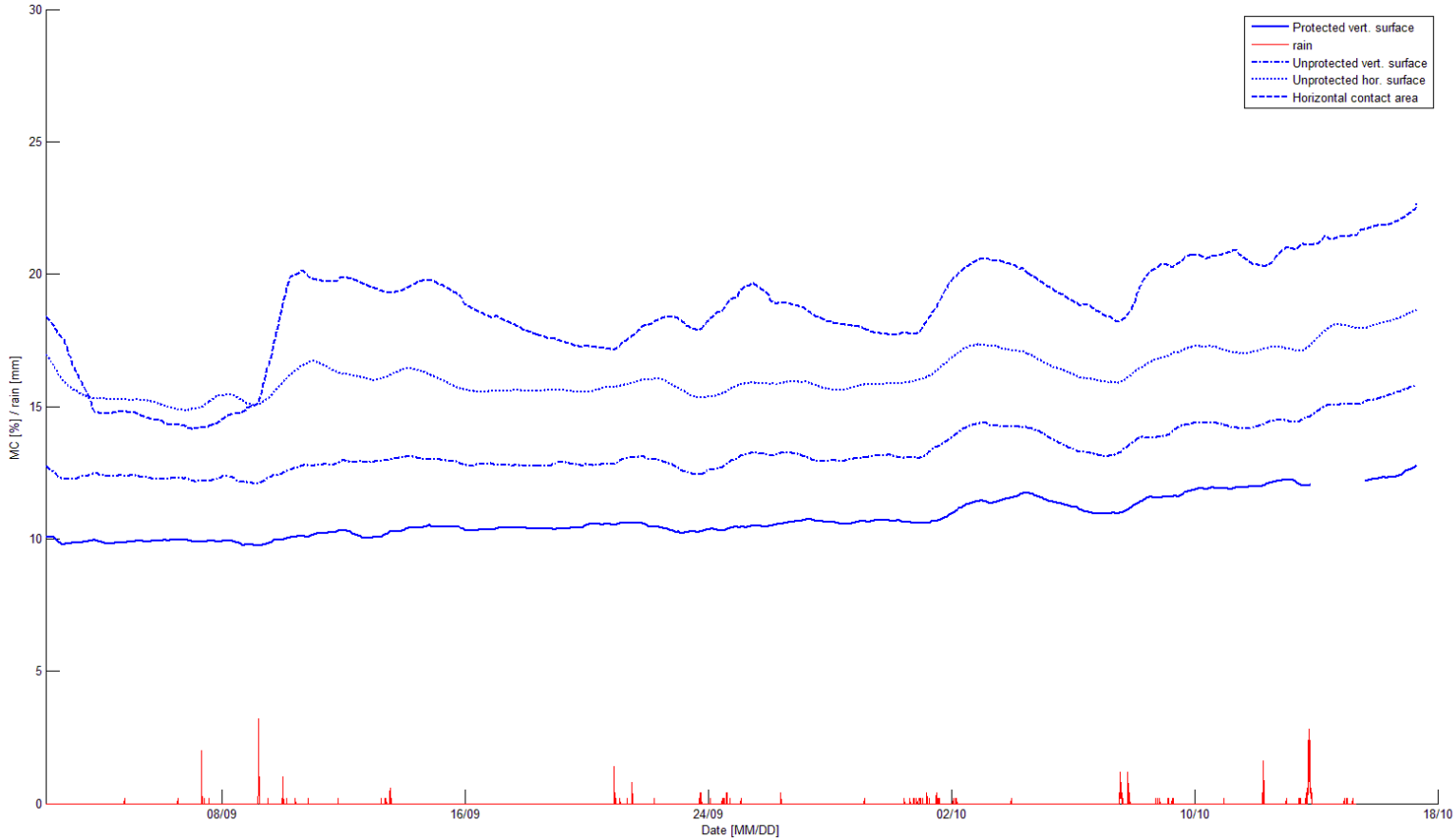
Preliminary results

- The following pictures are showing the mean MC of 3 specimens over time for.
- A moving average filter has been applied (24 hours)
- A distinction between transversal and longitudunal moisture transport is made

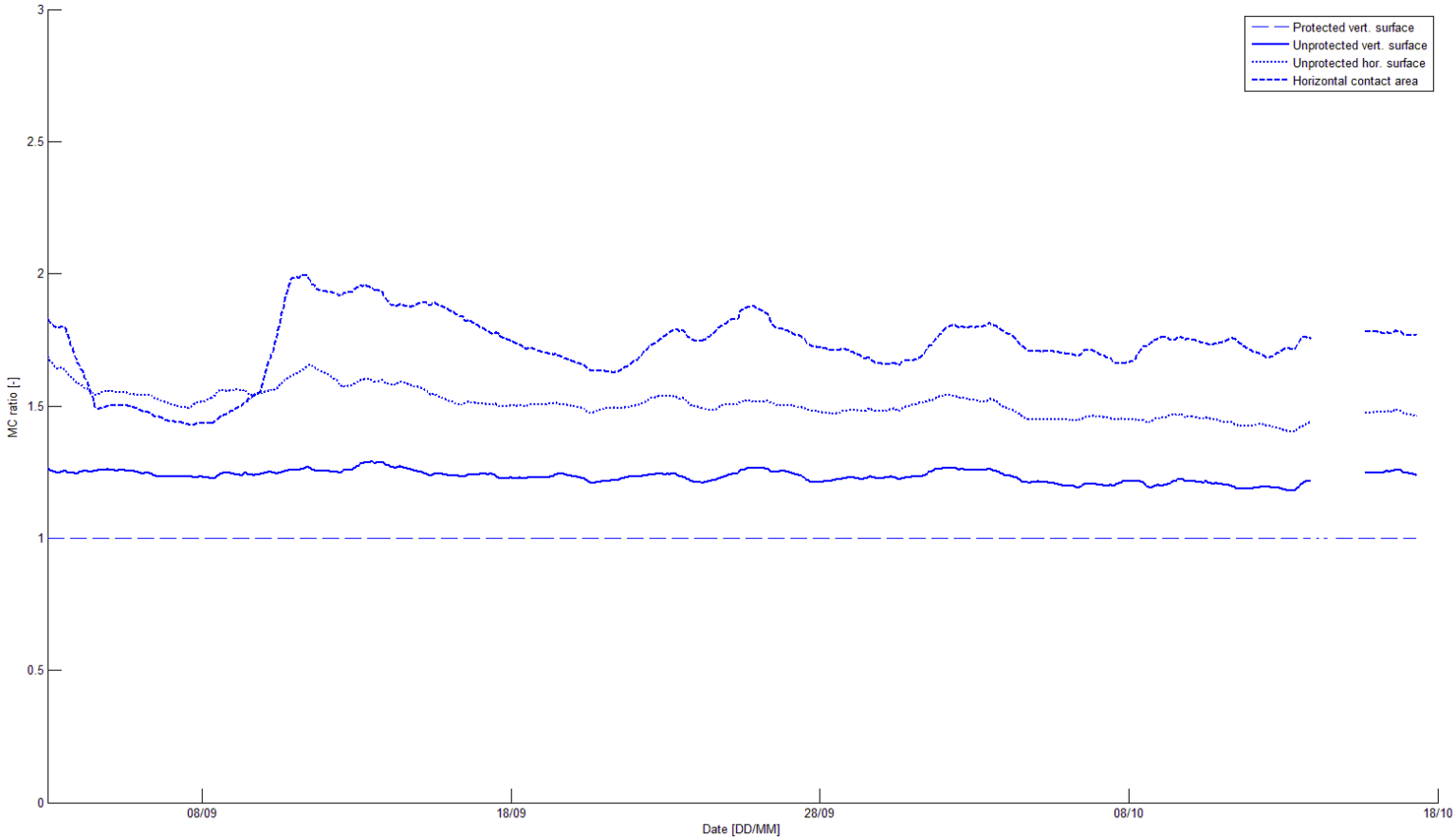
Longitudunal moisture transport



Transversal moisture transport



MC ratio (relative performance)



Relative performance

- The relative performance as described in Isaksson and Thelandersson (2013) is used to rate the performance of the various details.

$$Relative\ performance = mean(^{MC}/_{MC_{ref}})$$

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Relative performance: Prel. results

BEAMS (TRANSVERSAL MOISTURE TRANSPORT)	RATIO
TOP SURF, PROTECTED	0,85
SIDE SURF, PROTECTED (REF)	1
VERTICAL CONTACT AREA, GAP < 5 MM	1,09
VERTICAL CONTACT AREA, GAP > 5 MM	1,09
VERTICAL CONTACT AREA, NO GAP	1,26
SIDE SURF, PARTIALLY PROTECTED 2	1,29
SIDE SURF, UNPROTECTED	1,30
RECTANGULAR STEEL PLATE	1,32
SIDE SURF, PARTIALLY PROTECTED 1	1,34
DOWEL	1,43
NAIL PLATE	1,44
CIRCULAR STEEL PLATE	1,47
TOP SURF, UNPROTECTED	1,54
HORIZONTAL CONTACT AREA (42X115)	1,61
HORIZONTAL CONTACT AREA (90X115)	1,62

COLUMN ENDS (LONGITUDUNAL MOISTURE TRANSPORT)	RATIO
20 MM DISTANCE (60X60) & DRIP NOSE (REF)	1
20 MM DISTANCE (115X115)	1,2845
END GRAIN IN CONTACT WITH CONCRETE	1,5143


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