A close look at flow of asphalt mixtures for improving the quality of roads

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Outline

- Introduction
- Background and objective
- Test development
  - Compaction Flow Test (CFT)
  - Flow measuring methods
- Results
- Conclusions
- Recommendations

Introduction

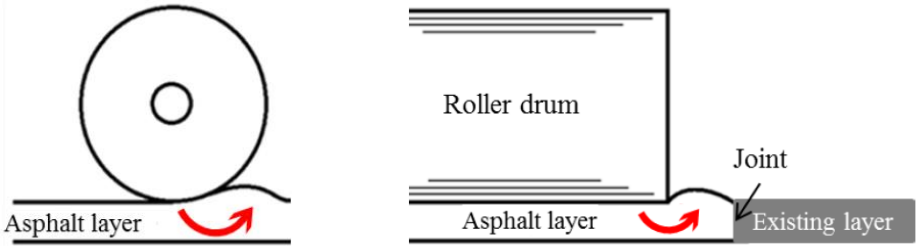
A decent knowledge about behavior of mixtures during construction can be used for constructing more durable roads.

Most of standard evaluating methods are designed for either before or after construction.

Recommended test methods for investigating mixture behaviors:

- Do not allow in-depth investigations
- Do not represent the field conditions

Observed flow during field compaction vs. Laboratory



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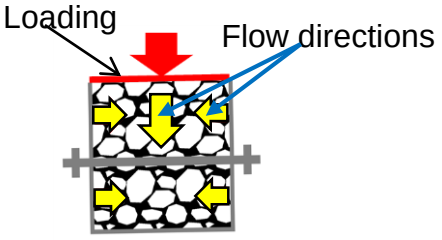
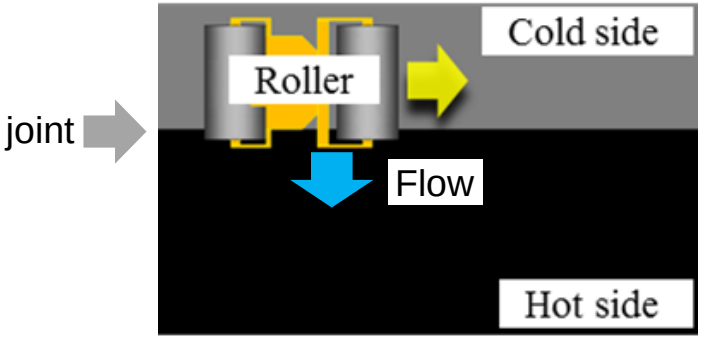


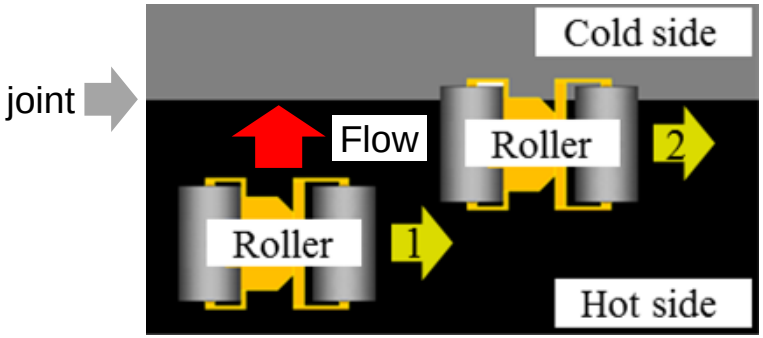
Gyratory compaction
(compactability measurements)

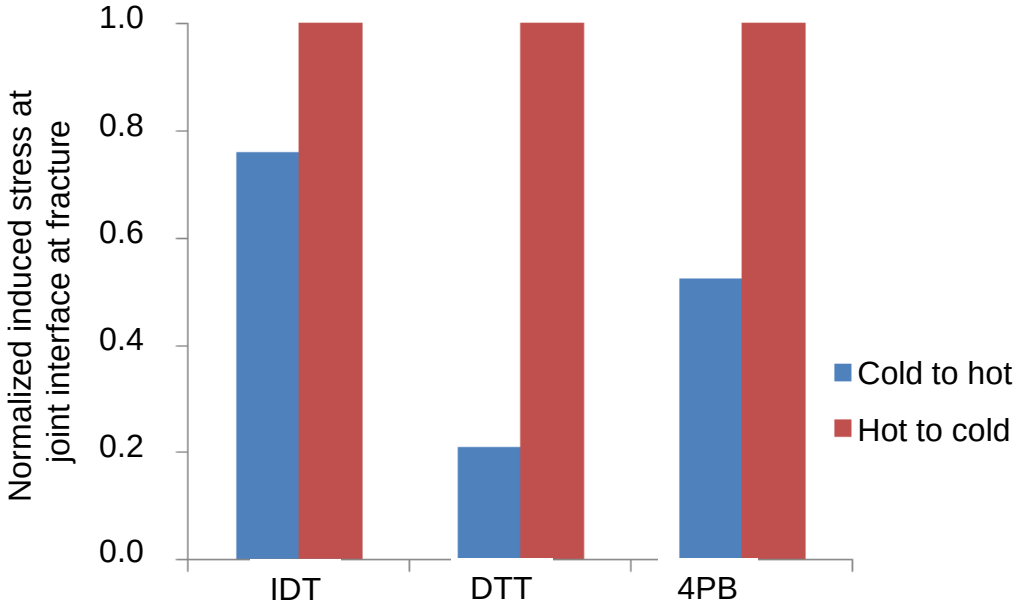
Background

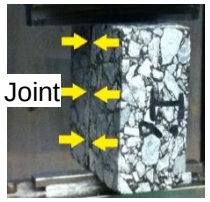
Importance of considering flow in all directions

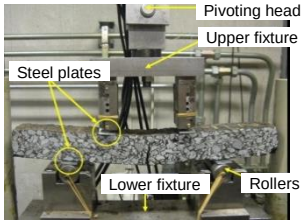
- Asphalt joint compaction











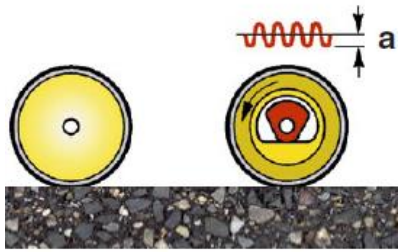
Background

Laboratory compaction simulators are not designed for close investigation on possible impact of construction parameters on behavior of mixtures :

- Lift thickness

- Bottom surface roughness

- Compaction modes



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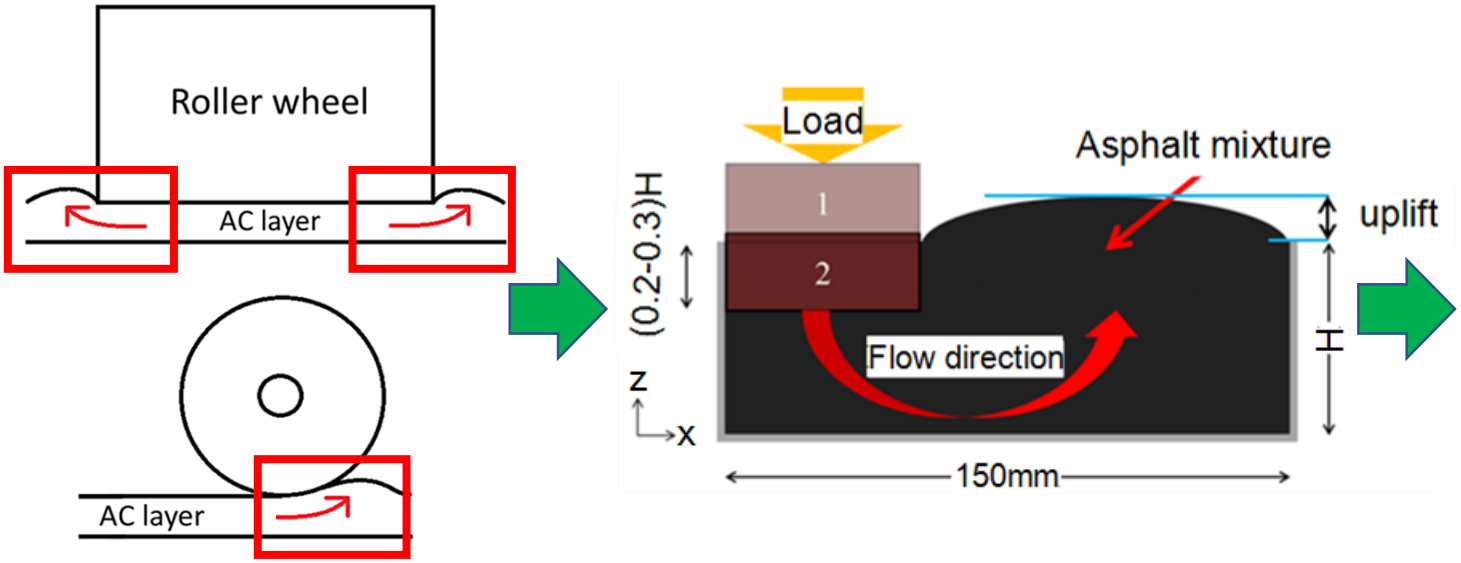
Objective

Developing an evaluating test method based on flow behavior of asphalt mixtures under compaction considering different construction parameters

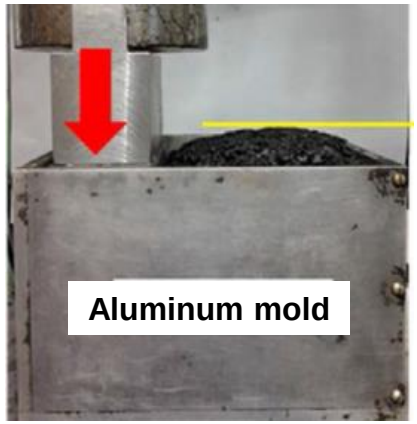
Test development

Compaction simulator with respect to expected flow of mixtures during compaction

- **Compaction flow test (CFT)**
  - Rectangular specimen (150x100xH)mm^3
  - Vertical loading (one third of the surface)

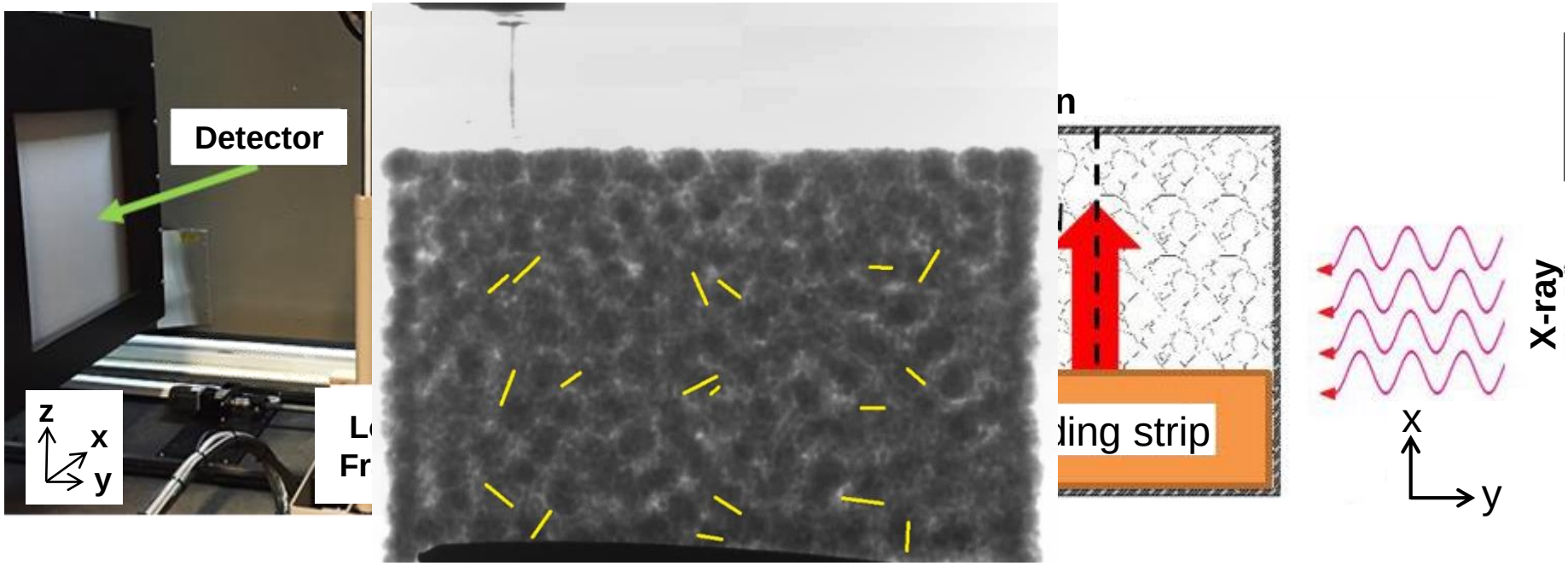


Compaction Flow Test (CFT)



Test development

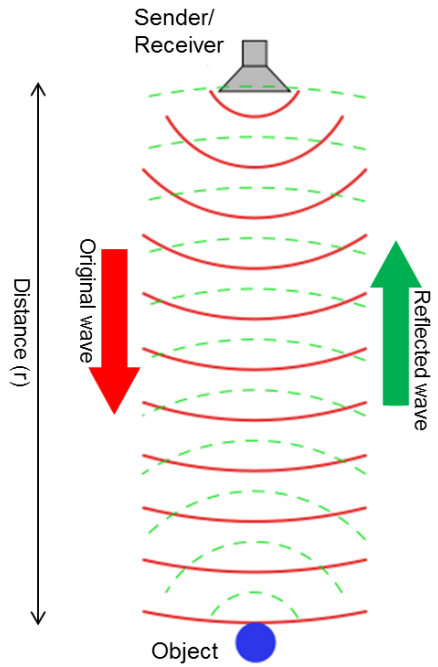
- Flow measuring method for laboratory investigation

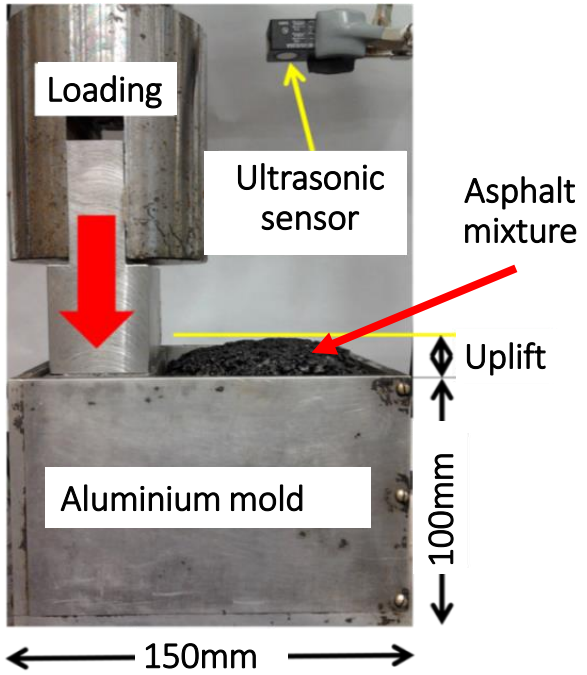


Test development

- Flow measuring method (uplift measurements)
  - Simpler and cheaper than X-ray

Ultrasonic sensor system

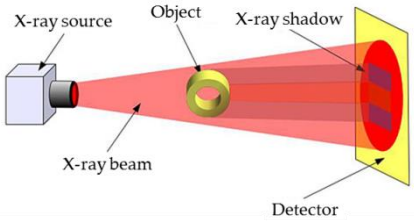




Test development

- Flow measuring method with potential for field measurements

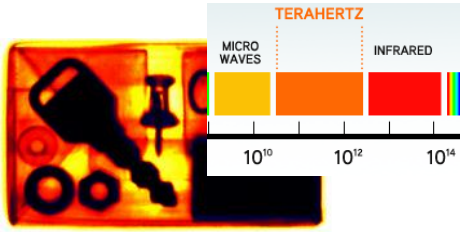
X-ray



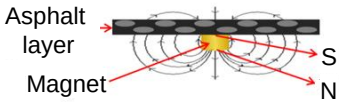
GPR

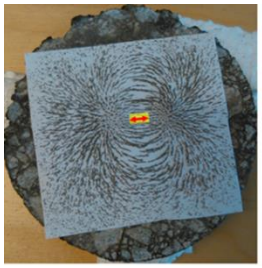
RFID

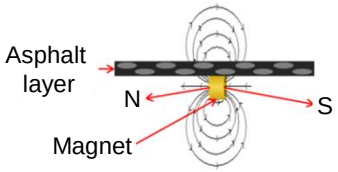
Terahertz

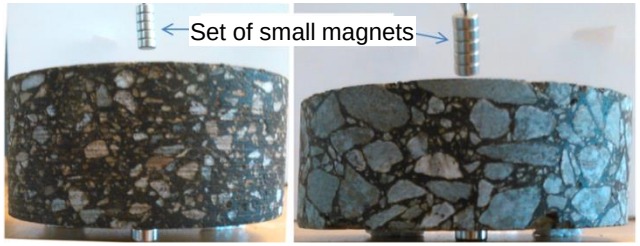


- Magnetic field positioning

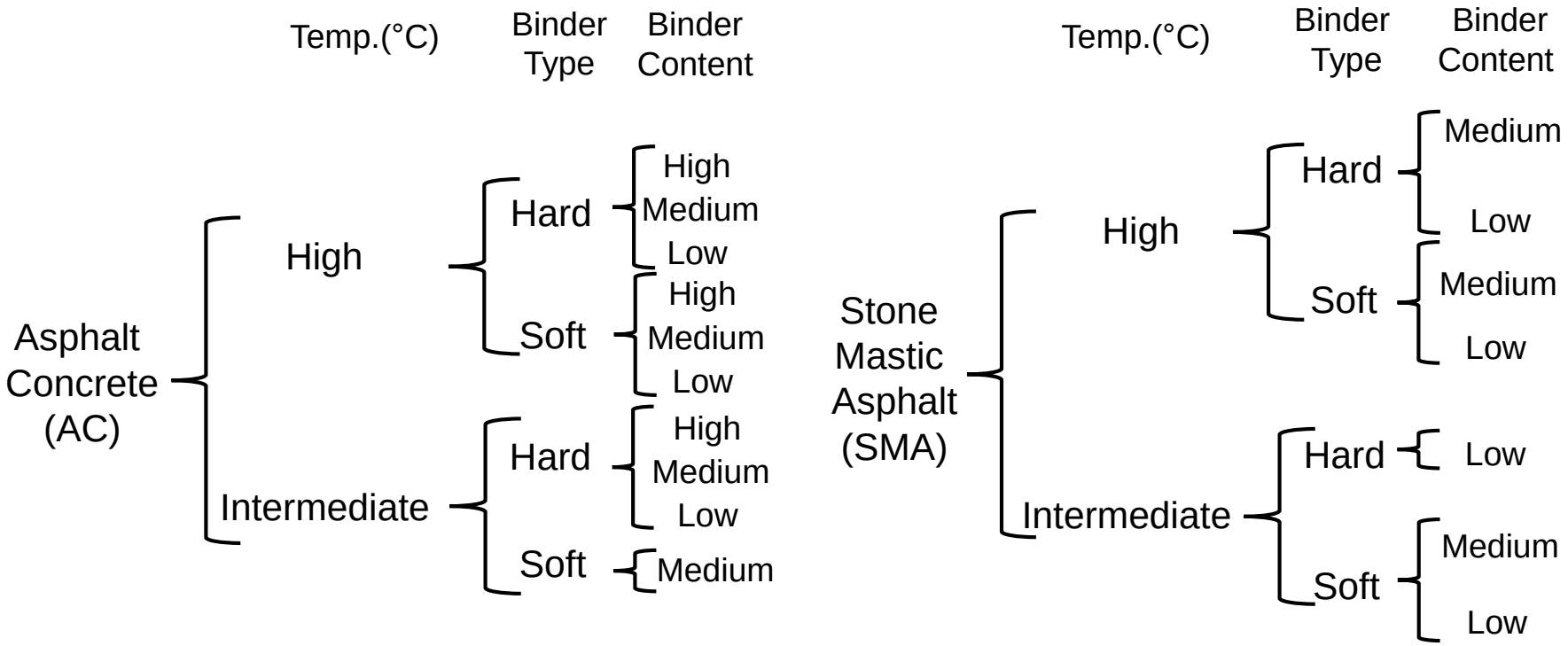


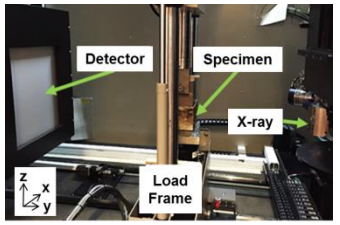






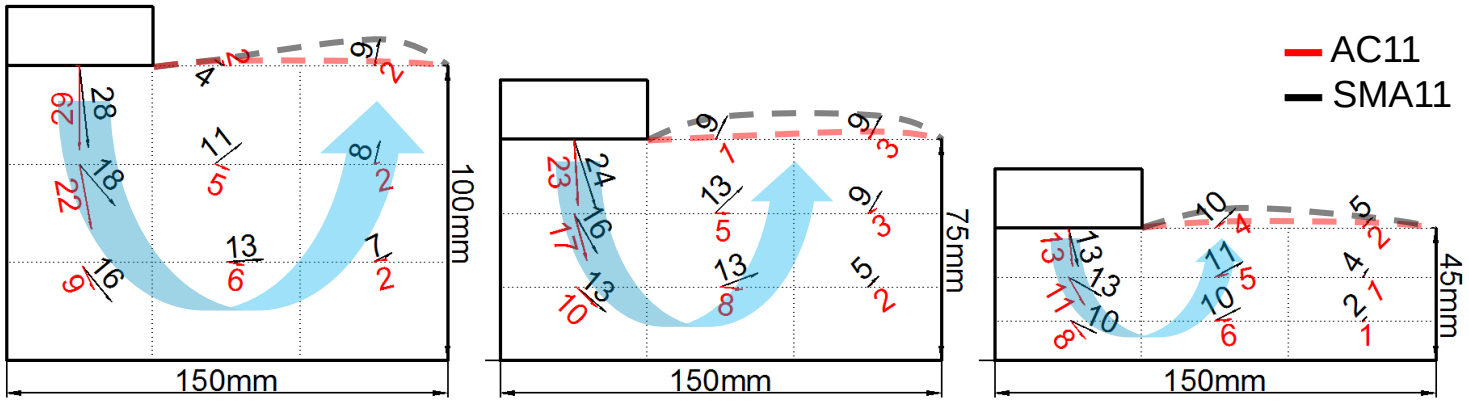
Materials


Temp.(°C)
Binder Type
Binder Content
Asphalt Concrete (AC)
High
Hard
High
Medium
Low
Soft
High
Medium
Low
Intermediate
Hard
High
Medium
Low
Soft
Medium
Temp.(°C)
Binder Type
Binder Content
Stone Mastic Asphalt (SMA)
High
Hard
Medium
Low
Soft
Medium
Low
Intermediate
Hard
Low
Soft
Medium
Low

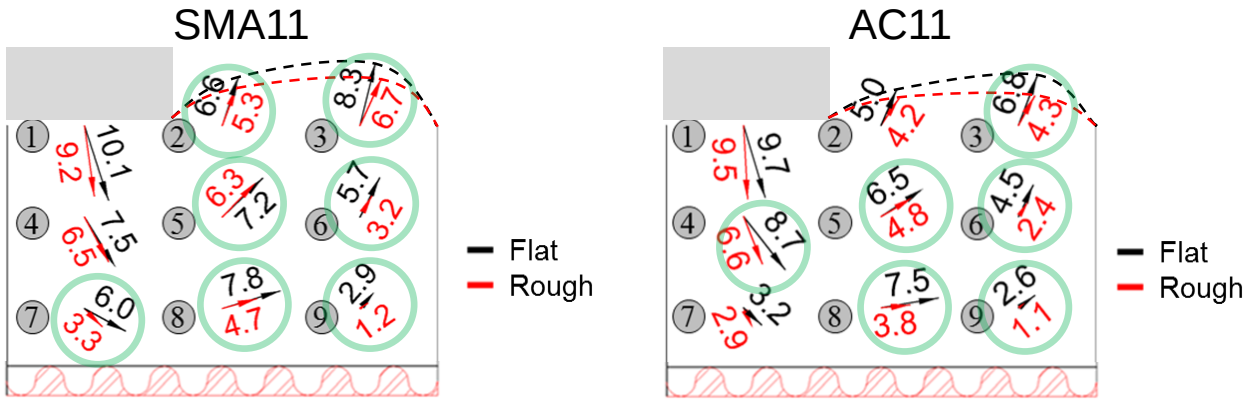


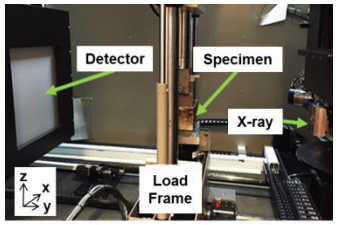
Results

- Impact of lift thickness on the flow



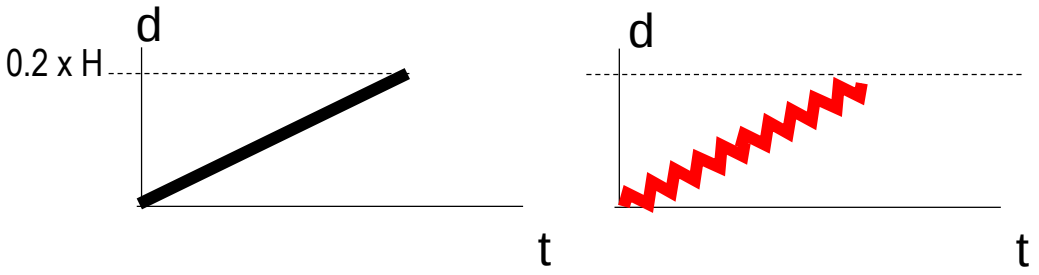
- Impact of grooving on the flow



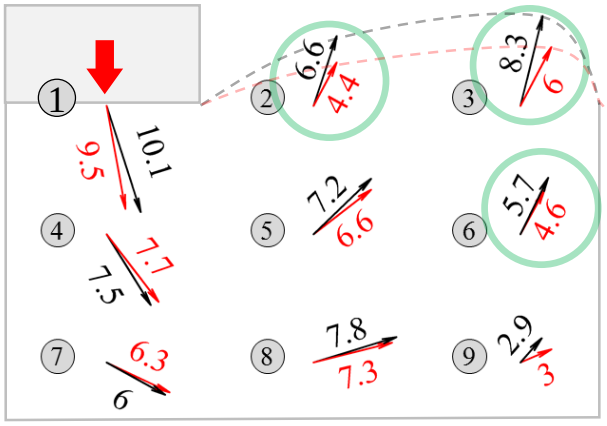


Results

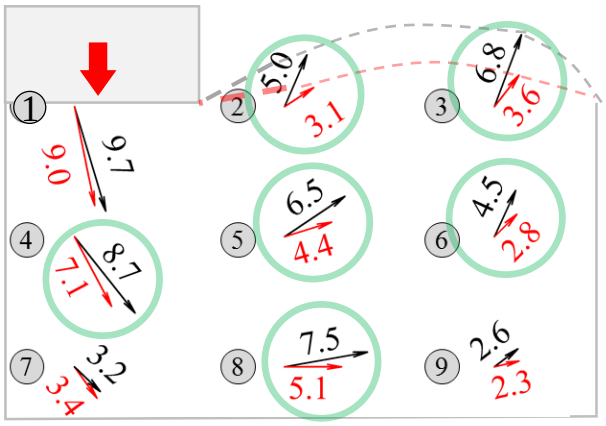
- Impact of vibration on the flow



SMA11

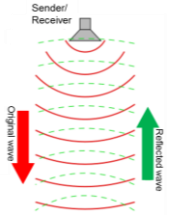


AC11

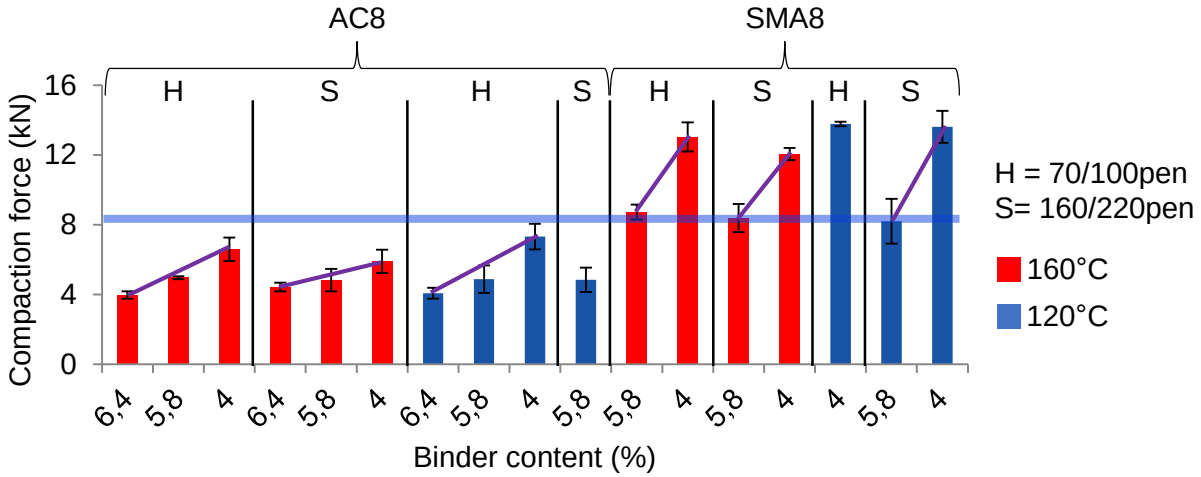


Static
Vibratory

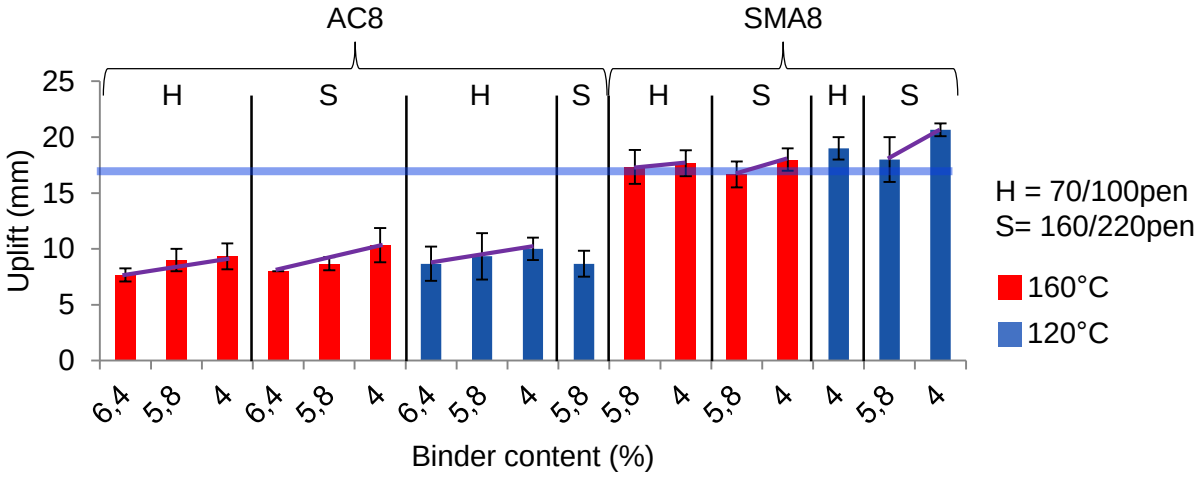
Results (ultrasonic sensor)



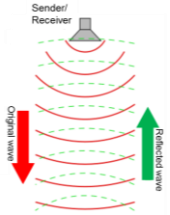
Compaction force



Uplift

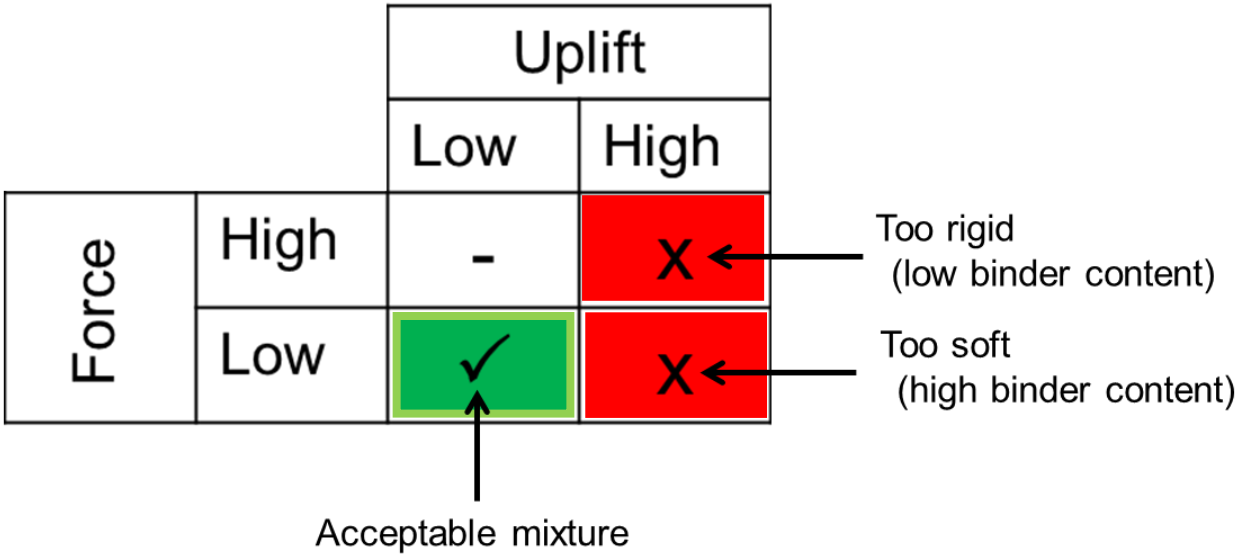


Results



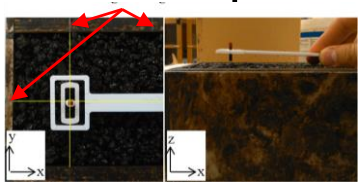
Characterization and evaluation of mixtures based on :

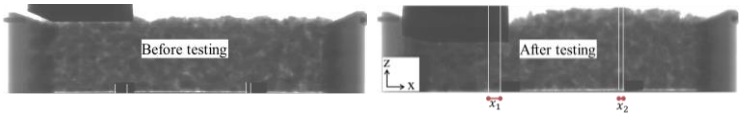
- Flow (uplift) behavior and
- Required compaction forces



Results

Magnetic field positioning vs. X-ray results





- Cold mixture

Replicates	Name	X-ray (mm)		Magnet (mm)		Error (mm)	
		x_1	x_2	x'_1	x'_2	e_1	e_2
4	Fine(0-5mm)	8.5	1.4	9.4	2.3	0.90	0.90
5	Fine(0-4mm)	8.6	1	8.4	2.5	-0.2	1.50
6	Coarse(0-16mm)	9	2.2	9.8	3.8	0.80	1.60

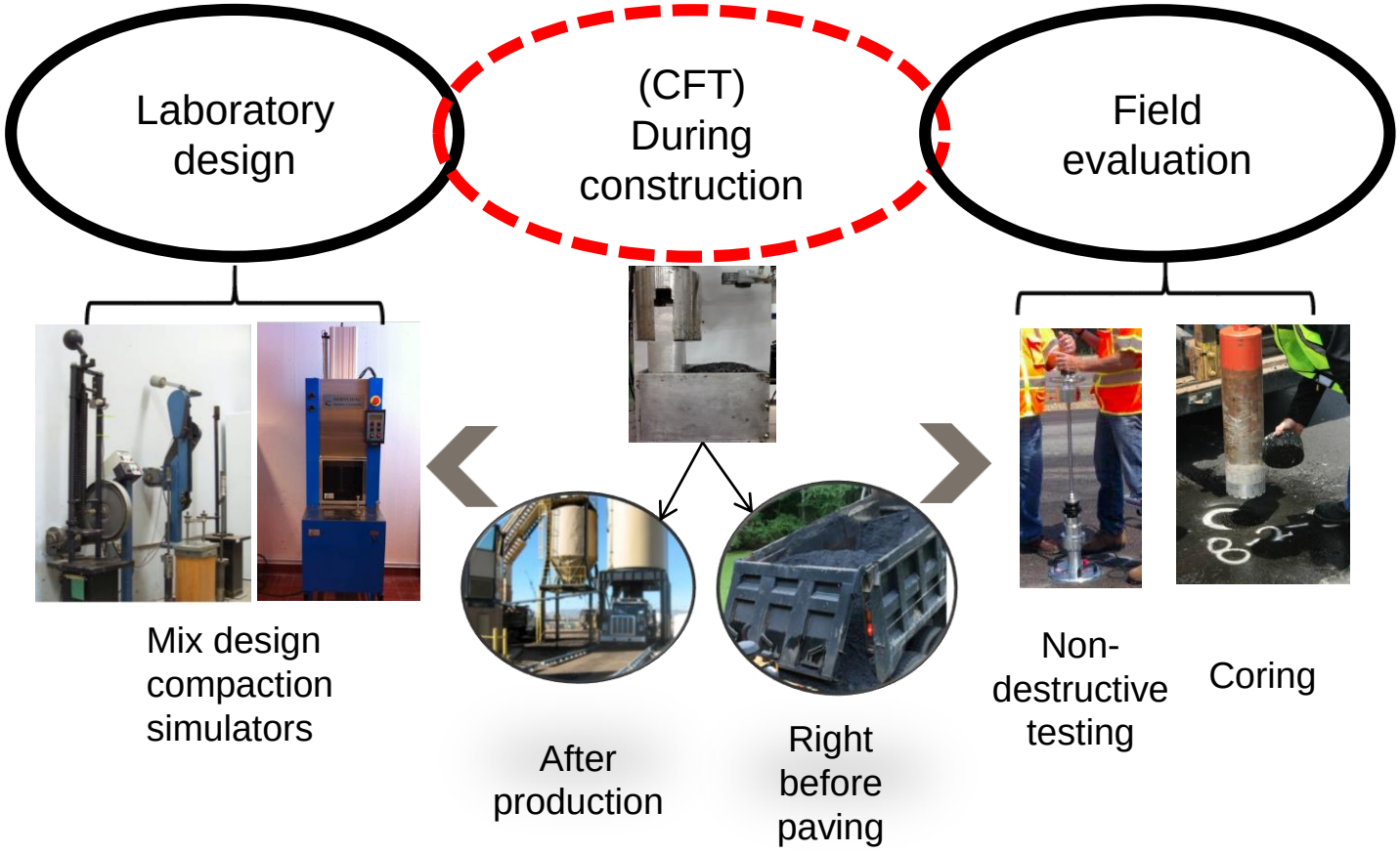
- Hot mixtures

Replicates	Name	X-ray (mm)		Magnet (mm)		Error (mm)	
		x_1	x_2	x'_1	x'_2	e_1	e_2
7	AC11	4.9	0.5	4.7	1.3	-0.2	0.8
6	SMA11	6.4	1.4	6.4	1.9	0	0.5

Conclusions

- **CFT** seems to be a useful method for making a in-depth study towards the construction phase.
- **CFT** appeared to be capable of becoming an in-site evaluating tool during the field construction.
- **CFT** can contribute to optimizing mix design and compaction in order to increase quality and produce more economical and environmental friendly roads.

Recommendation



Thank you for your attention!

KTH VETENSKAP OCH KONST

TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

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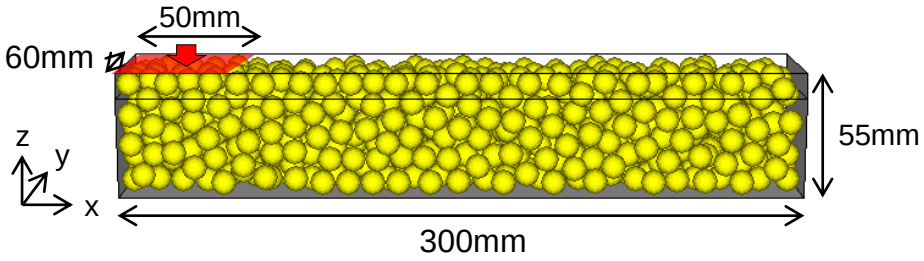
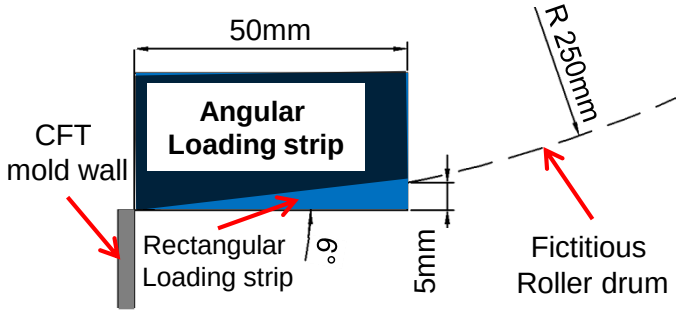
Design optimization

CFT design for future use:

1. Mold size



2. Loading strip geometry



3. Loading rate
   - 15mm/min
   - 75mm/min
   - 150mm/min