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LIME IN COLD RECYCLING

TRIAL FIELD FIGLINE VALDARNO (ITALY) 4-6 SEPTEMBER 2013

Partners

Lime in cold recycling

Trial field - September 4th and 5th 2013, Figline Val d'Arno - Italy

Research aim

The presence of excessive residual water is one of the main problems in the cold recycling process. The use of lime as active filler in the cold recycling techniques (in situ or in plant) can be an efficient way to solve these problems: the calcium oxide hydration and its exothermic properties can take out a large amount of water in few time; this means that adding lime just before compaction can be a simple and effective system to take out the excessive water amount from the mix.

Furthermore the lime active filler can give other additional advantages:

1. hydrated lime can stabilize the clay particles that could be present in the aggregates mixture (in particular for the in situ recycling of unbound layers);
2. lime can work as active filler improving the adhesion between bitumen and aggregates;
3. lime can improve the water damage resistance of the recycled mixtures resulting in a greater durability.

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Research aim

The research project will evaluate and quantify the behavior of cold recycled mixtures, both with foam asphalt and with emulsion technique, when lime is used as active filler; attention will be mainly focused on the following three points:

Workability
Mechanical performance
Durability.

Research work organization

The research work will be organized in phases and will involve the partners in accord with the work plan described below. The scientific plan and the research work organization (P.I. activities) will be made by Dr. Jenkins, Dr. Airey, Dr. Marradi, and Dr. Tebaldi with the support of Dr. Page Green and Dr. Collings.

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Research development

Phase 1:
Laboratory optimization of recycled mixtures with different amount of bituminous binder (bitume emulsion and foam bitumen) and active filler (cement and lime).

Phase 2
Design and construction of an experimental trial field on a constructing road

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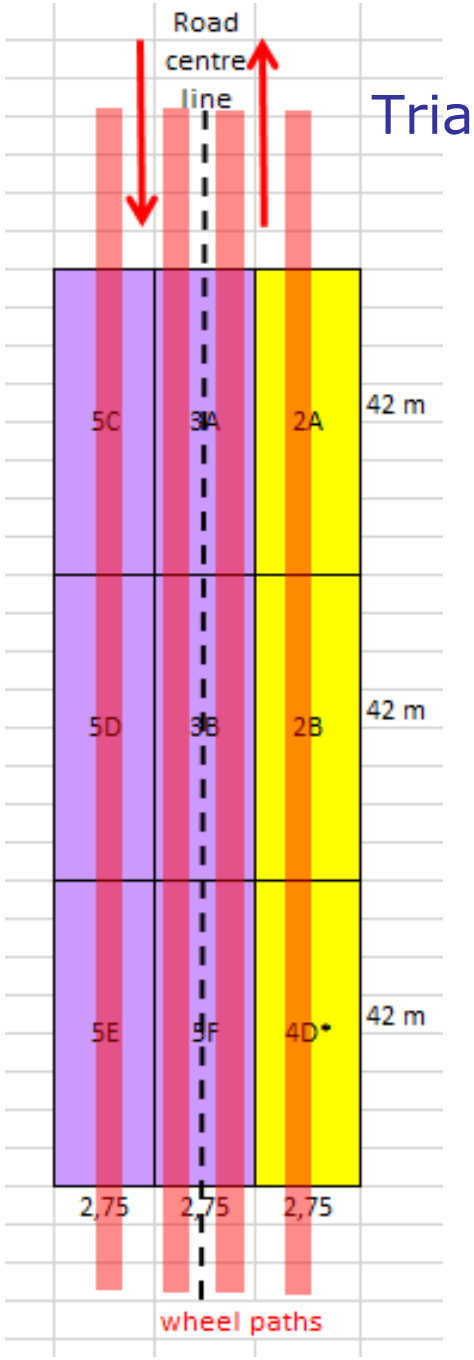

Types of mixtures tested

Emulsion	2A(3%BE,1%C,2%L,1.5%MF)
	2B(3%BE,1%C,0%L,3.5%MF)
	4D*(3%BE,2.5%C,0%L,2%MF)
Foam Bitumen	3A(2%FB,1%C,2%L,1.5%MF)
	3B(2%FB,1%C,0%L,3.5%MF)
	5C(3%FB,2.5%C,2%L,0%MF)
	5D(3%FB,2.5%C,0%L,2%MF)
	5E(3%FB,0%C,2%L,2.5%MF)
	5F(3%FB,0%C,3%L,1.5%MF)

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Mixing process

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Mixing process

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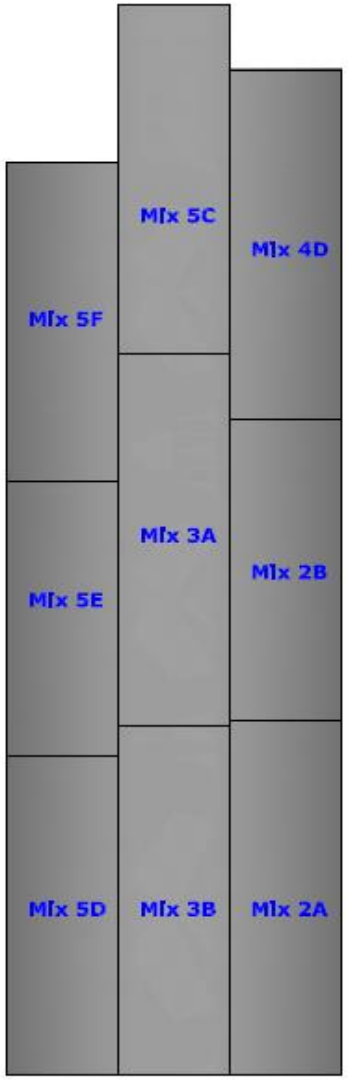
General characteristcs of mixtures



Mixtures	Mix 2A	Mix 2B	Mix 4D	Mix 3B	Mix 3A	Mix 5C	Mix 5D	Mix 5E	Mix 5F
Length	40 m	34 m	39 m	39	42	39	36	31	36
Width	3,25 m	3,1 m	3,4 m	2,9 m	2,9 m	2,9 m	3,7 m	4 m	4 m
Thikness	17 cm	17 cm	17 cm	17 cm	17 cm	17 cm	17 cm	17 cm	17 cm
Date Lying	4/09 17.00	5/09 9.00	5/09 11.00	5/09 13.30	5/09 15.00	5/09 16.30	5/09 17.30	5/09 18.00	5/09 18.30

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LWD and FWD testing of the subgrade

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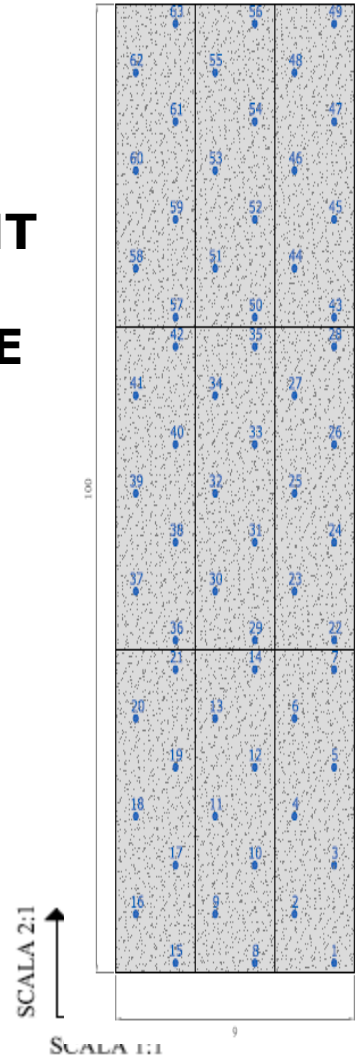
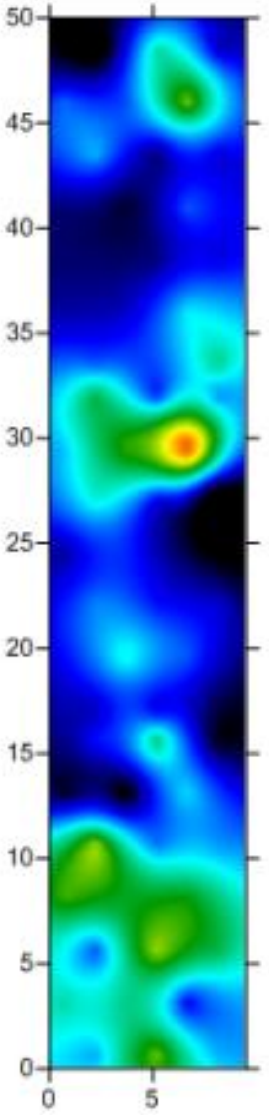
LWD and FWD testing of the subgrade – Surface Modulus on Sungrade

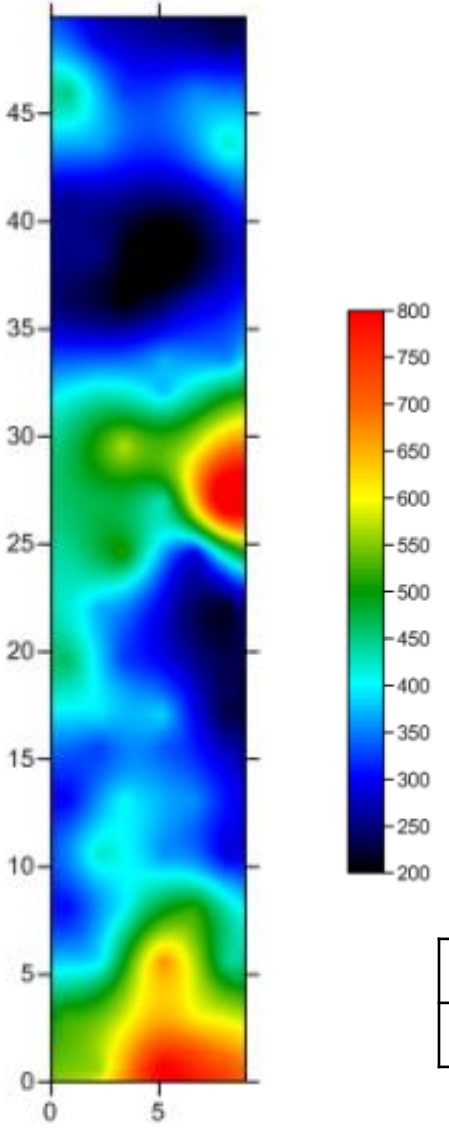
TEST POINT ON THE SUBGRADE



LWD



FWD



Length	meters
Modulus	Megapascal

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Construction process

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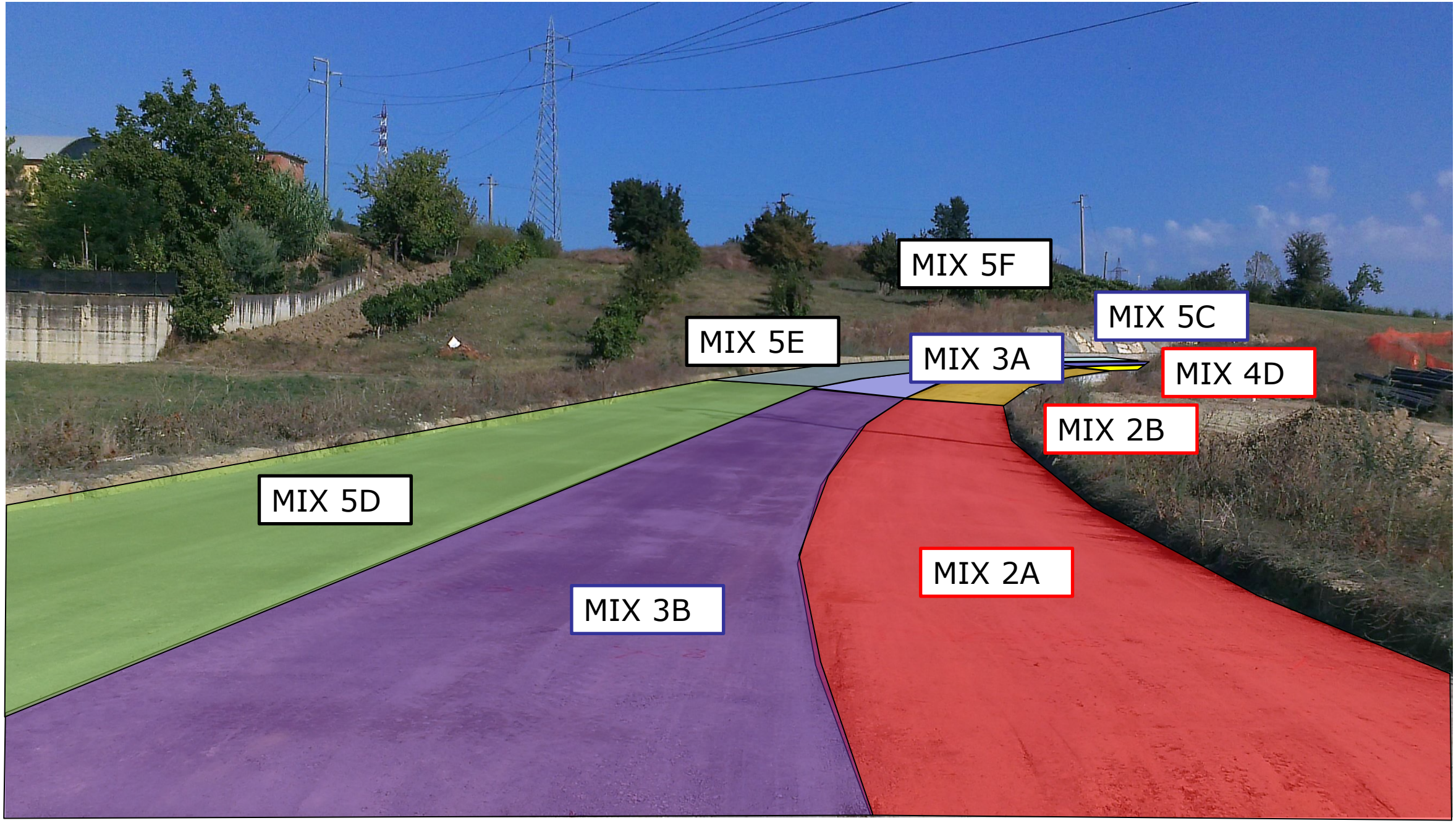
MIX 5F
MIX 5C
MIX 5E
MIX 3A
MIX 4D
MIX 2B
MIX 5D
MIX 2A
MIX 3B

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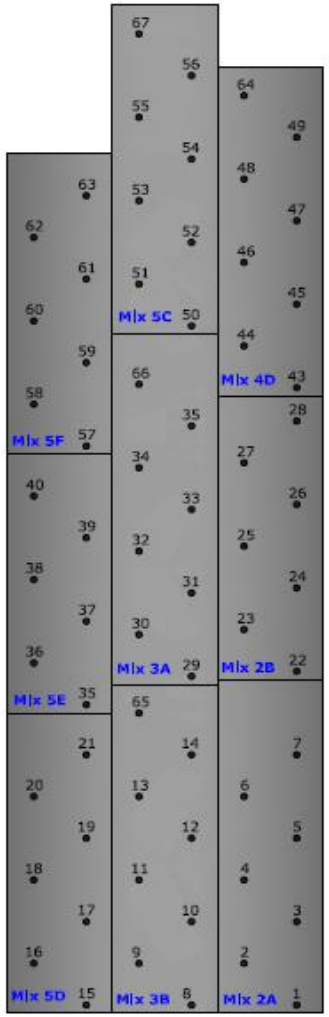
LWD

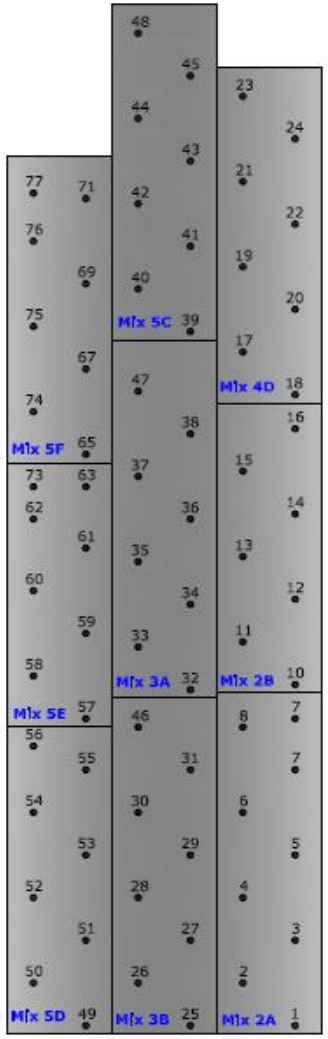
LWD TEST POINT ON BASE



Testing

FWD

FWD TEST POINT ON BASE



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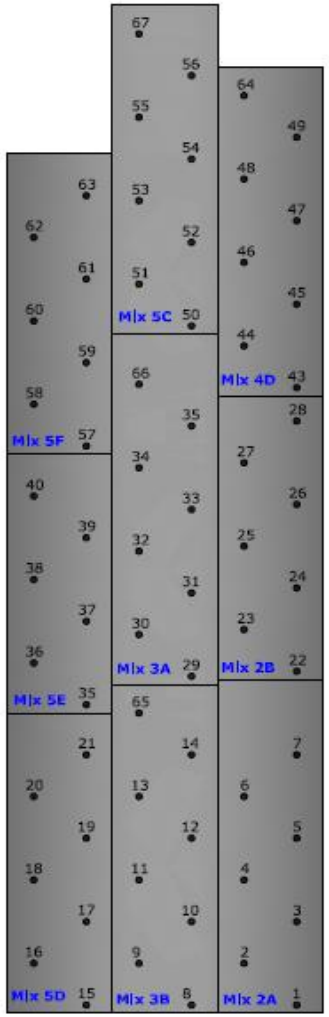
LWD

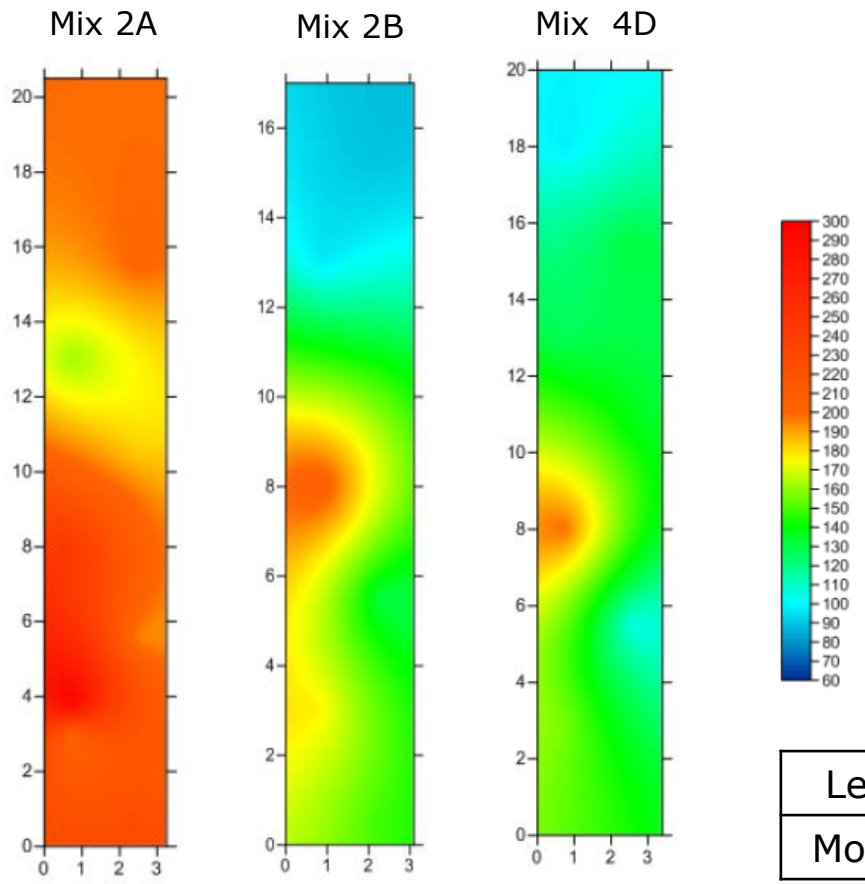
LWD TEST POINT ON BASE



Testing

TESTS CARRIED OUT AFTER 4 HOURS CURING

EXAMPLE OF RESULTS REPRESENTATION



Length	meters
Modulus	Megapascal

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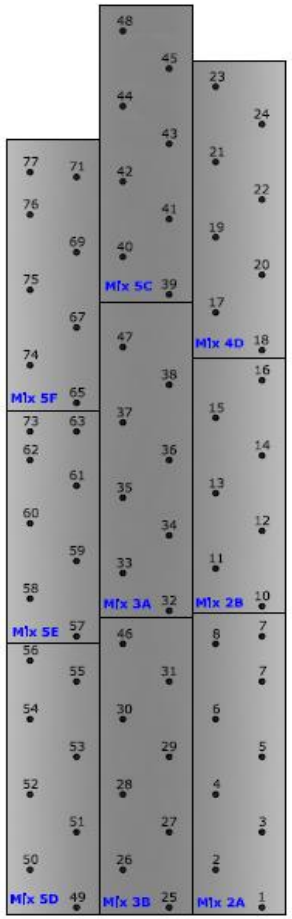
FWD

FWD TEST POINT ON BASE



Testing

TESTS WERE CARRIED OUT AFTER DIFFERENT PERIODS OF CURING

24 HOURS OF CURING

↓

14 DAY OF CURING

↓

28 DAY OF CURING

↓

JANUARY 2014

↓

?...AFTER TRAFFIC OPENING...

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ISSUES

TEMPERATURE DEPENDENCY OF THE MIXTURES

Temperature correction using the Asphalt Institute Equation

$$E_{Ts} = 10^{\alpha \cdot (T^2 - T_S^2)} \times E$$

Ets (MPa)	Modulus at a reference temperature
T (° F)	Test Temperature
Ts (° F)	Reference Temperature - In this case the reference temperature was assumed 20° C (68° F)
E (MPa)	Modulus at the test temperature
α	Costant value used to represent the temperature sensitivity of the mix - for Asphalt concrete in assumed to be 0.00012-0.00013. In this case a value of 0.00008 was assumed, based on previous research at the Unversity of Pisa

WHICH IS THE CORRECT APPROACH????

Temperature correction Plati

Plati, Loizos, Papavasiliou and Kaltosounis "Investigation In Situ Properties of Recycled Asphalt Pavement with Foamed Asphalt as Base Stabilizer

$$E_{FA}(20°C) = E_{FA}(T) \cdot 1.037^{(T-20)}, \qquad (3)$$

where $E_{FA}(20°C)$ is the estimated FA modulus at the reference temperature (20°C) and $E_{FA}(T)$ is the estimated FA modulus at the measured temperature (T).

Temperature correction HD_29

HD 29/08 Design Manual for Road and Bridges – Data for Pavement Assessment. Temperature correction for asphalt mixes

$$E_{20} = E_T \cdot 10^{(0.0003 \cdot (20 - T^2) - 0.022 \cdot (20 - T))}$$

E20 (MPa)	Modulus at a reference temperature
T (° F)	Test Temperature
Et (MPa)	Modulus at the test temperature

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ISSUES

TEMPERATURE DEPENDENCY OF THE MIXTURES

POSSIBLE SOLUTION

Multiple FWD tests in the same day (same curing), in the same test location (same stiffness characteristics), making tests in different temperature condition.

Exploit the temperature variation of the pavement during the day.

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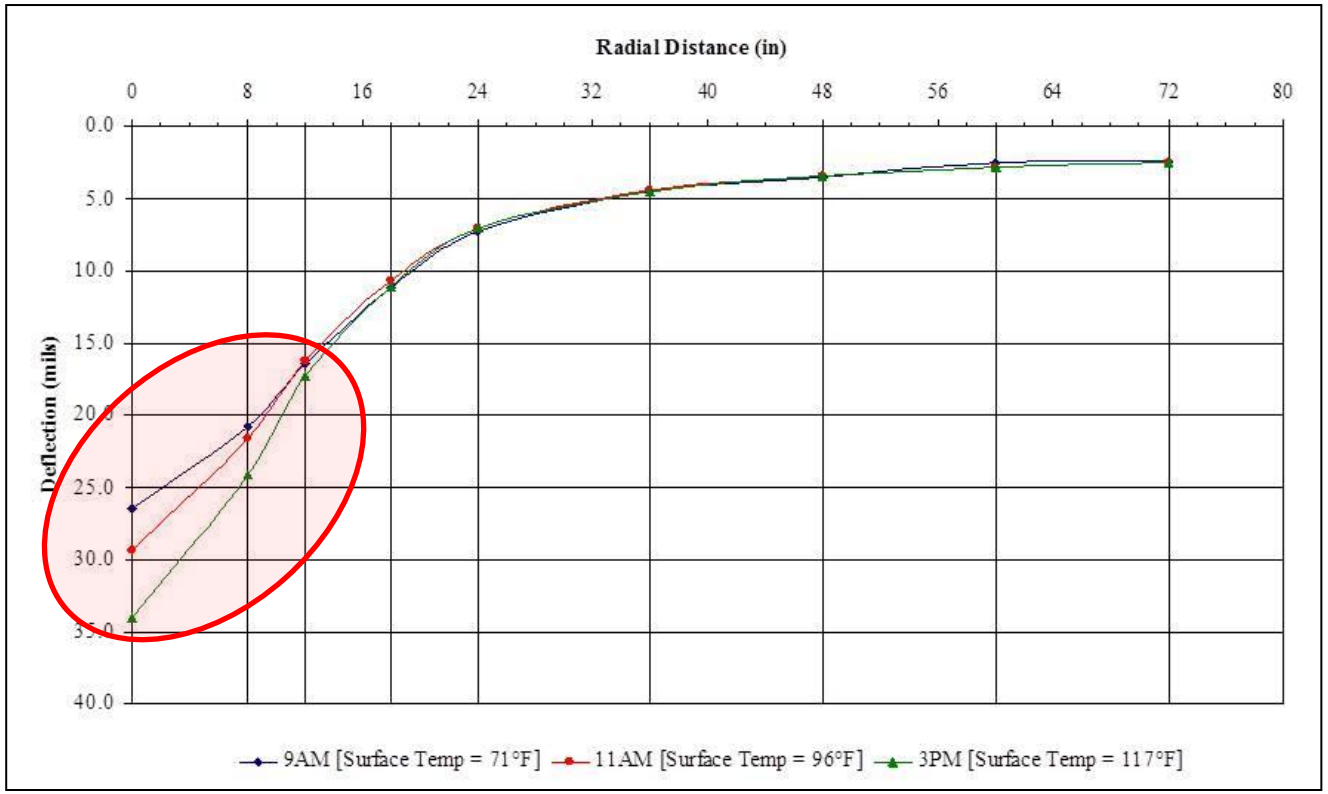
FUTURE ACTIVITIES

FWD tests to investigate temperature dependency of the mixes and to evaluate the stiffness evolution after opening to traffic.



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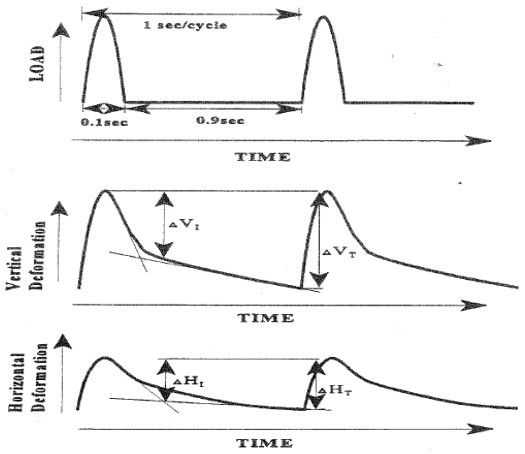
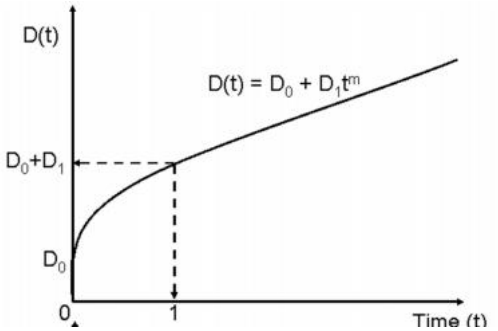
FUTURE ACTIVITIES

Tests on laboratory compacted specimen and cores following the Superpave IDT Protocol

1 Resilient Modulus



2 Creep compliance test



3 Strength test