LISBOA 2010
MAY 25/28

16th World Meeting

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Study on Asphalt Pavement Technologies Targeting the Prevention of Global Warming

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Outline of Presentation

- Use of Warm-Mix Asphalt
  - Basic concept
  - Laboratory test results
  - CO_2 reduction at paving work
- Solar Heat-blocking Pavement
  - Basic concept
  - Effect of temperature reduction
  - Case study (Airport taxiway)
- Conclusions

Warm-mix Asphalt
- Background -

Warm-Mix Asphalt:

- Reduction in CO_2
- Improvement of workability, especially in winter

- In 1997, NIPPO developed the additive agent called "***ECOFINE***"
- It can be used for both straight and modified asphalts
- **30 °C** to reduction in mixing temperature was achieved

What is *ECOFINE* ?

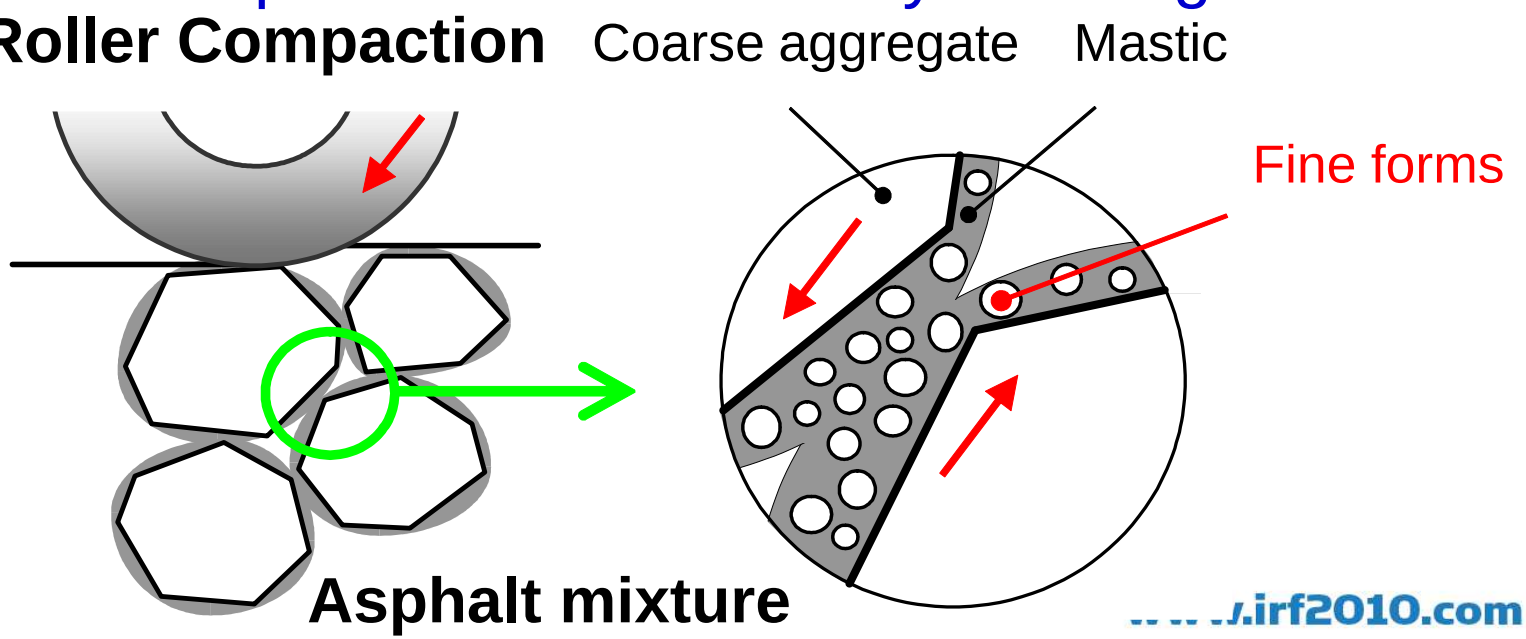
Forming-based special additive agent for WMA technology

Production: Fine forms occur in bitumen

A volume of bitumen increases considerably

Workability of bitumen will be improved

Laying: Good compaction is achieved by “bearing effect”

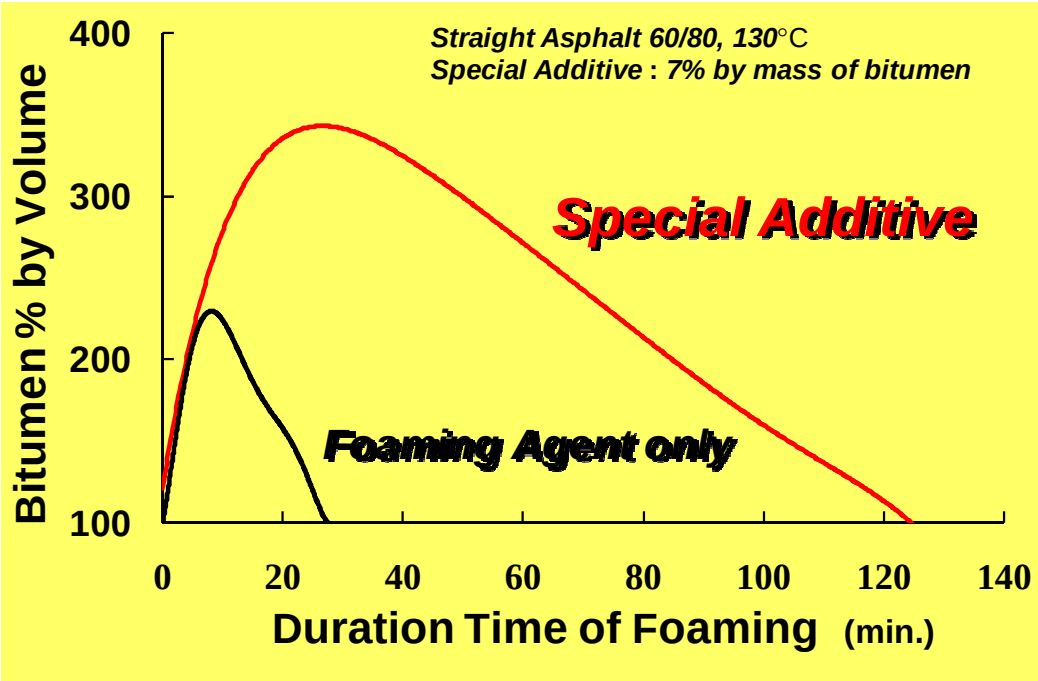


Properties of *ECOFINE*

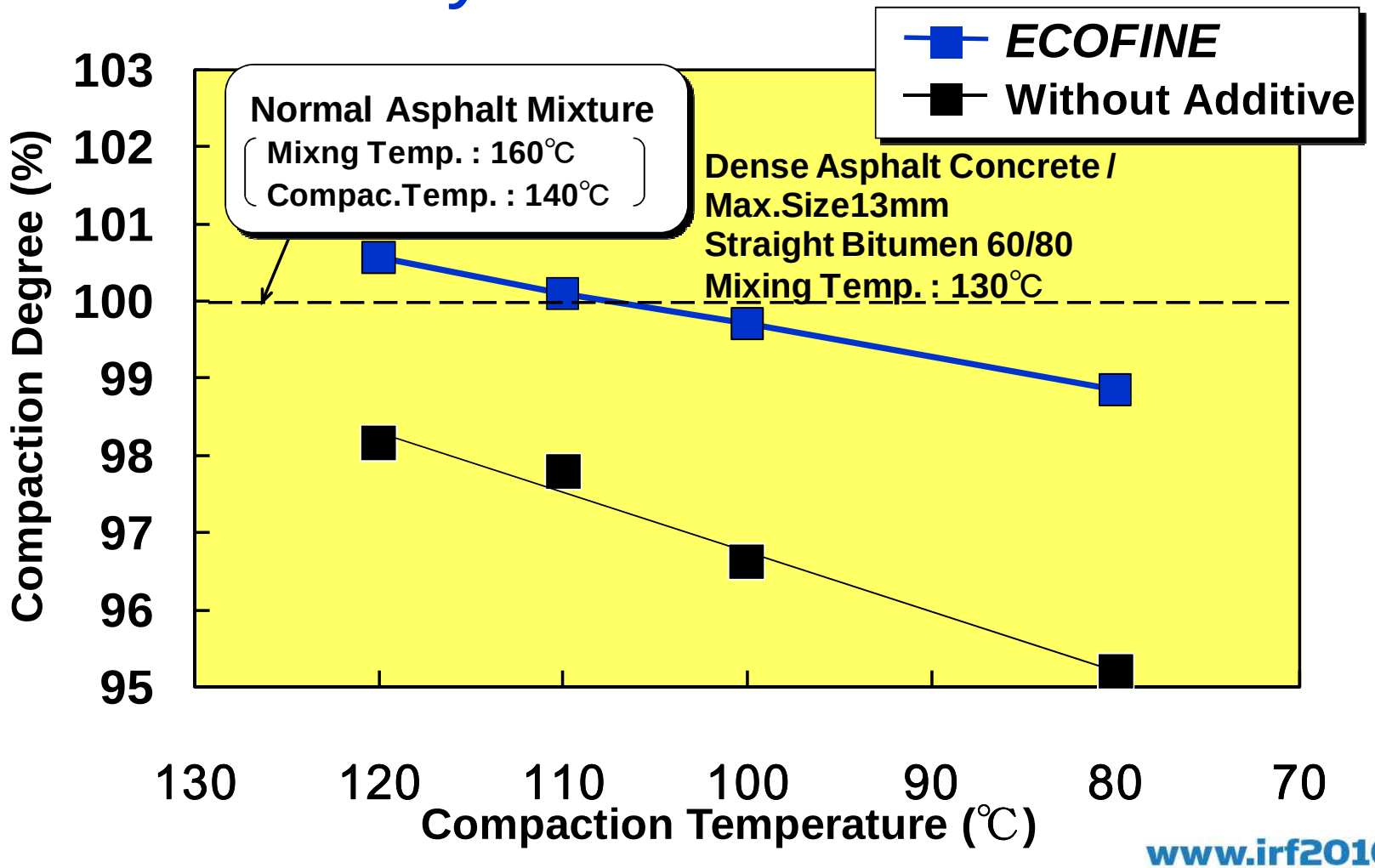
-Micro-form generation-

Special Additive

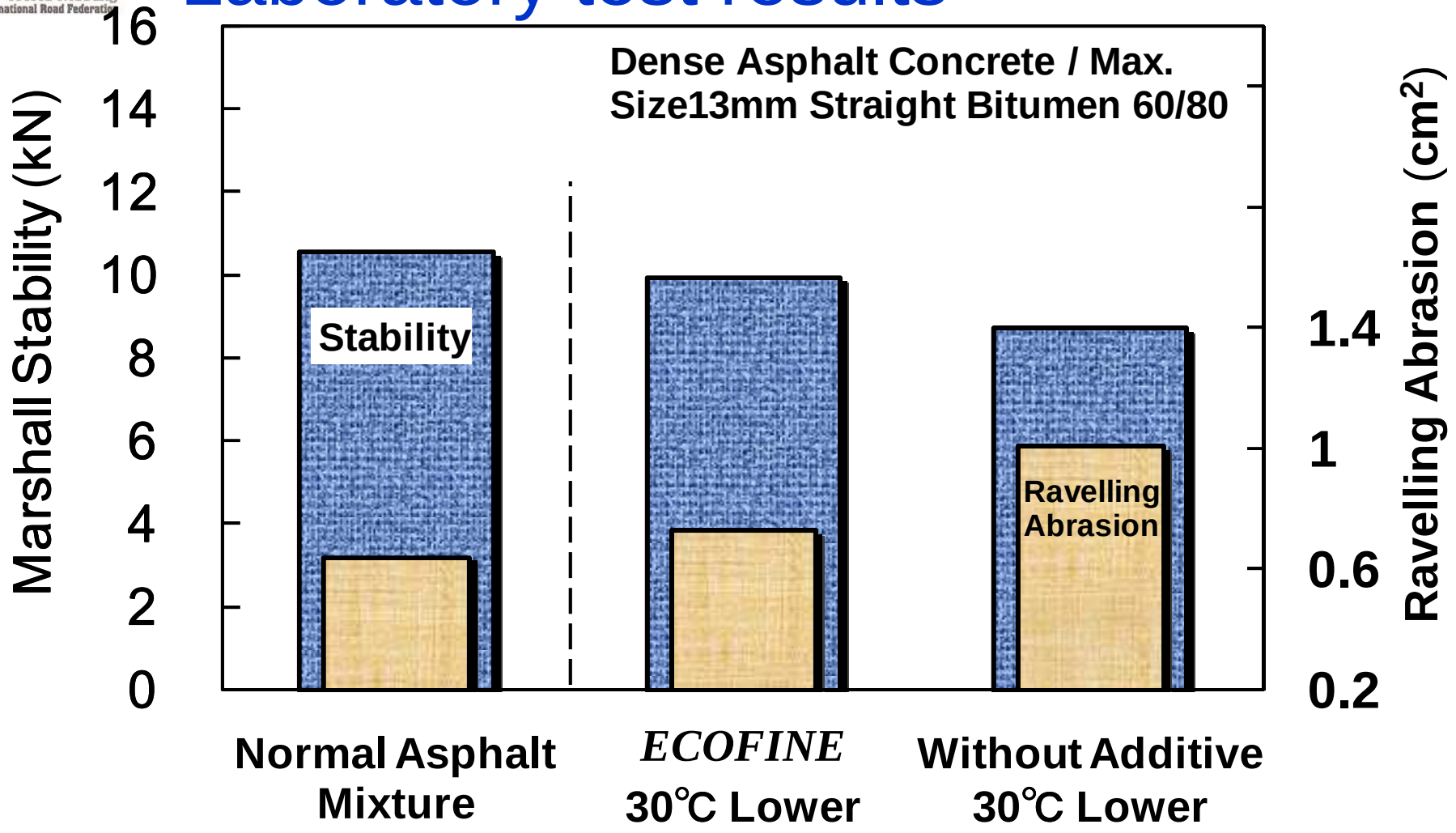
- Add the agent of 2 kg/ton
- Keep forming state for a long duration;
- Laboratory: Approx. 120 min.
- Site: 4 to 5 hours



Warm-mix Asphalt
Laboratory test results



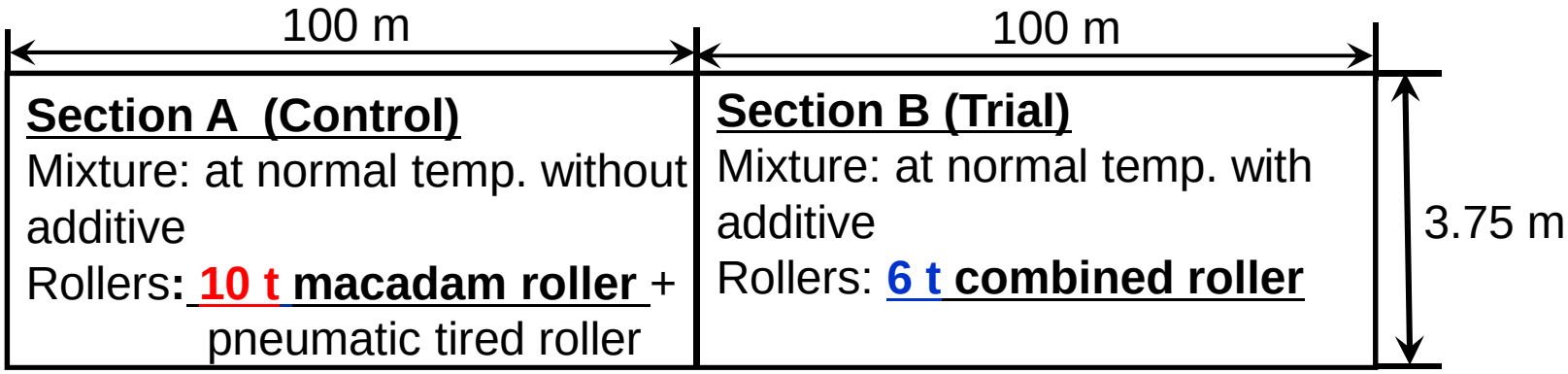
Warm-mix Asphalt
Laboratory test results



Simplification of paving equipment train: CO_2 reduction at paving work

- Simplified compaction train was examined

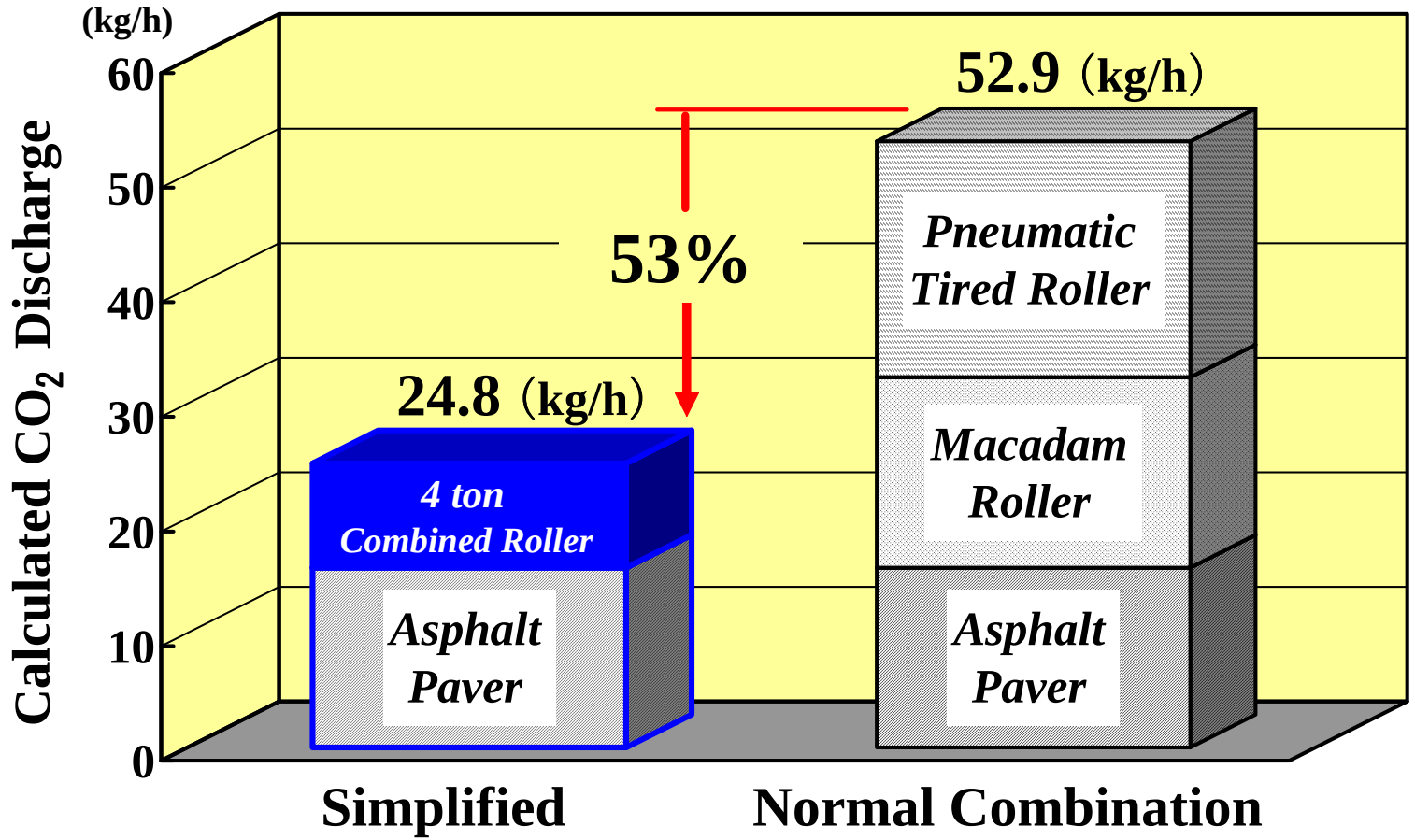
Plane figure



Construction condition and test results

Items \ Type of Mix.		Surface Mixture Type 20	
Applied Section		A (Control)	B (Simplified)
Special Addition		0	3.5
Mixing Conditions	Capacity of Mixer	2,000 kg/batch	
	Dry Mixing Time (sec)	10	
	Wet Mixing Time (sec)	36	
	Mixing Temp. (°C)	160	
Compaction (time)	Macadam Roller	3	-
	Pneumatic Tired Roller	7	-
	6 t Combined Roller	-	11
Cored Sample	Density (g/cm³)	2.339	2.324
	Air Void (%)	4.8	5.4
	Compaction Degree (%)	**98.9**	**98.6**
Evenness (σ) (mm)		**0.79**	**0.78**

CO_2 reduction at paving work
- Calculated CO_2 emission -



- Approx.53% of CO_2 reduction can be saved thanks to the special additive

Solar Heat-blocking Pavement

Solar Heat-blocking Pavement - Background -

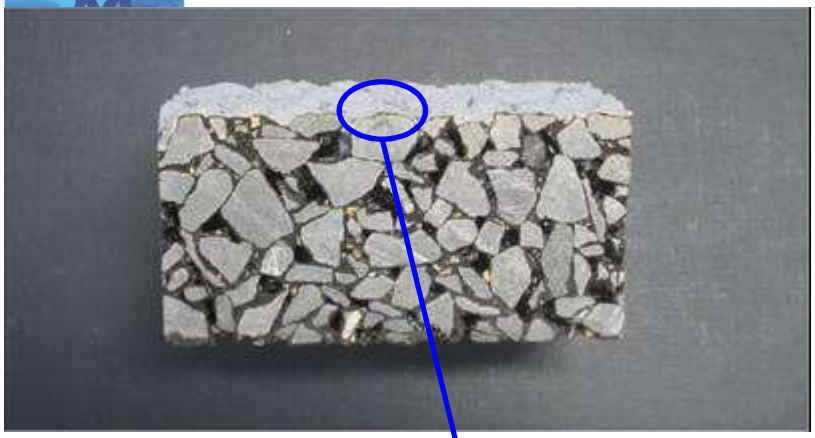
Urban areas and pavements in Japan

- Surface temperatures of asphalt pavement **reach 60˚C or higher** in summer
- Asphalt surfaces cover approx. **20%** of urban areas
- Pavement is a source of heat, similar to concrete structures

Hotter pavement:

- leads to the urban heat island phenomenon
- may affect the heath of pedestrians due to the higher temperatures

Basic concept of solar reflective technology

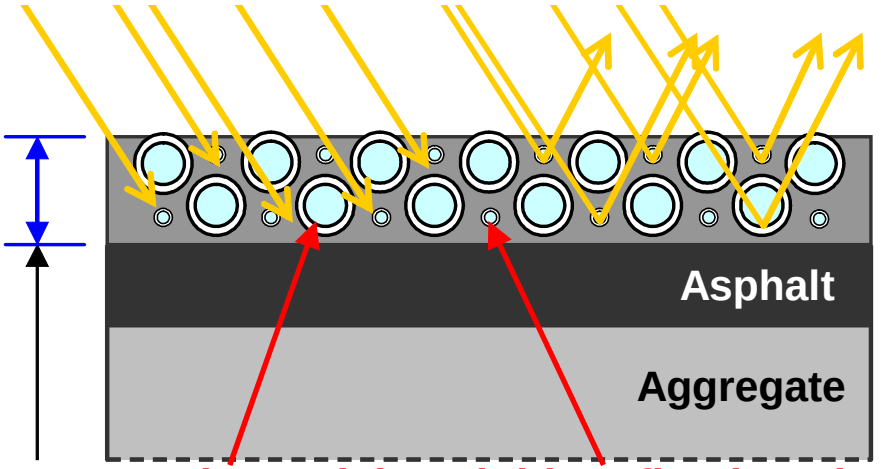


Surface course of hot mix asphalt

Solar radiation

- ***Low reflection for the visible rays***
- ***High reflection for the near infrared rays***

Apply high albedo and dark colored thin treatment materials

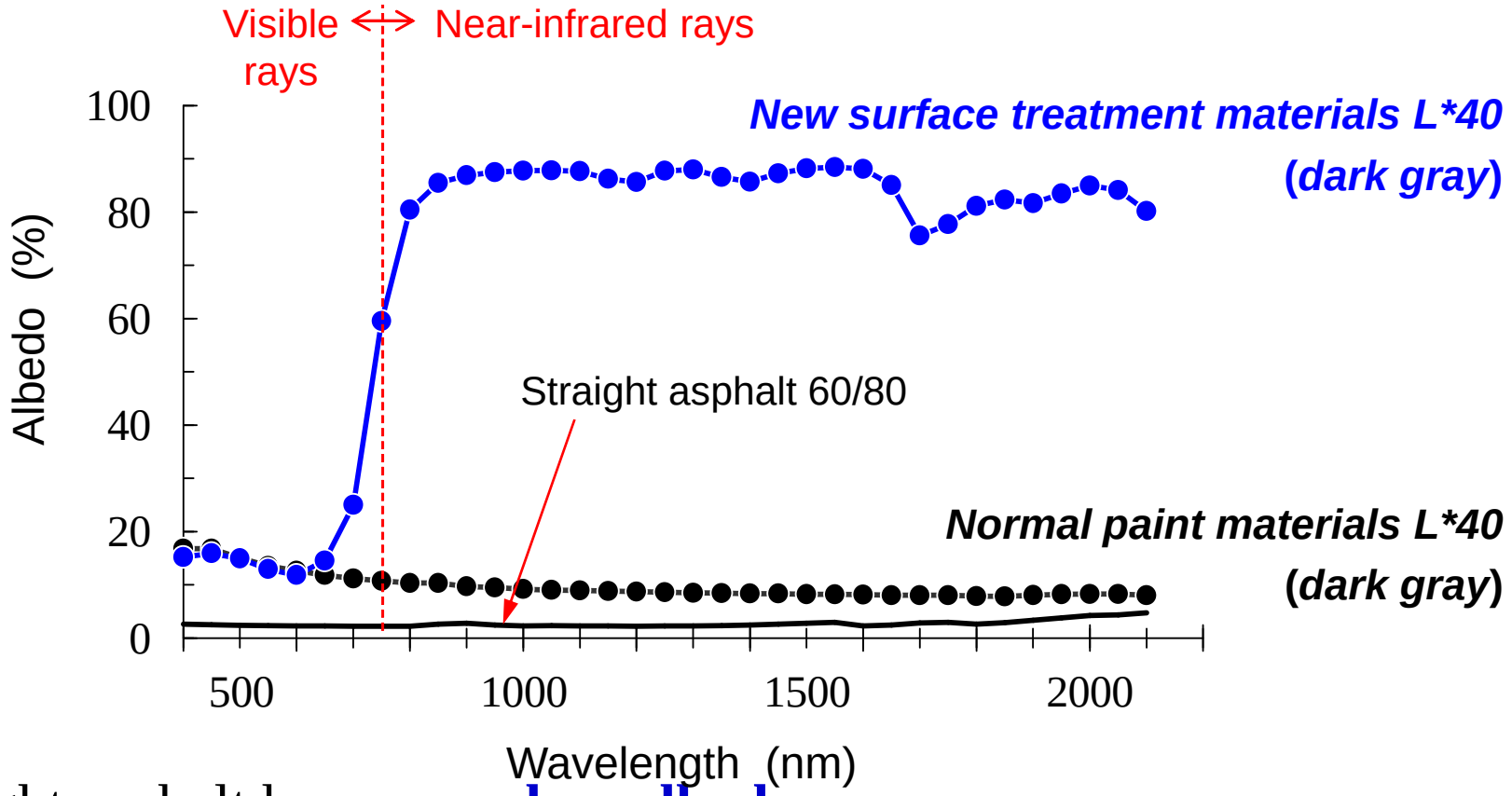


Component of hot mix asphalt

Hollow ceramic particle ***Highly reflective pigment***

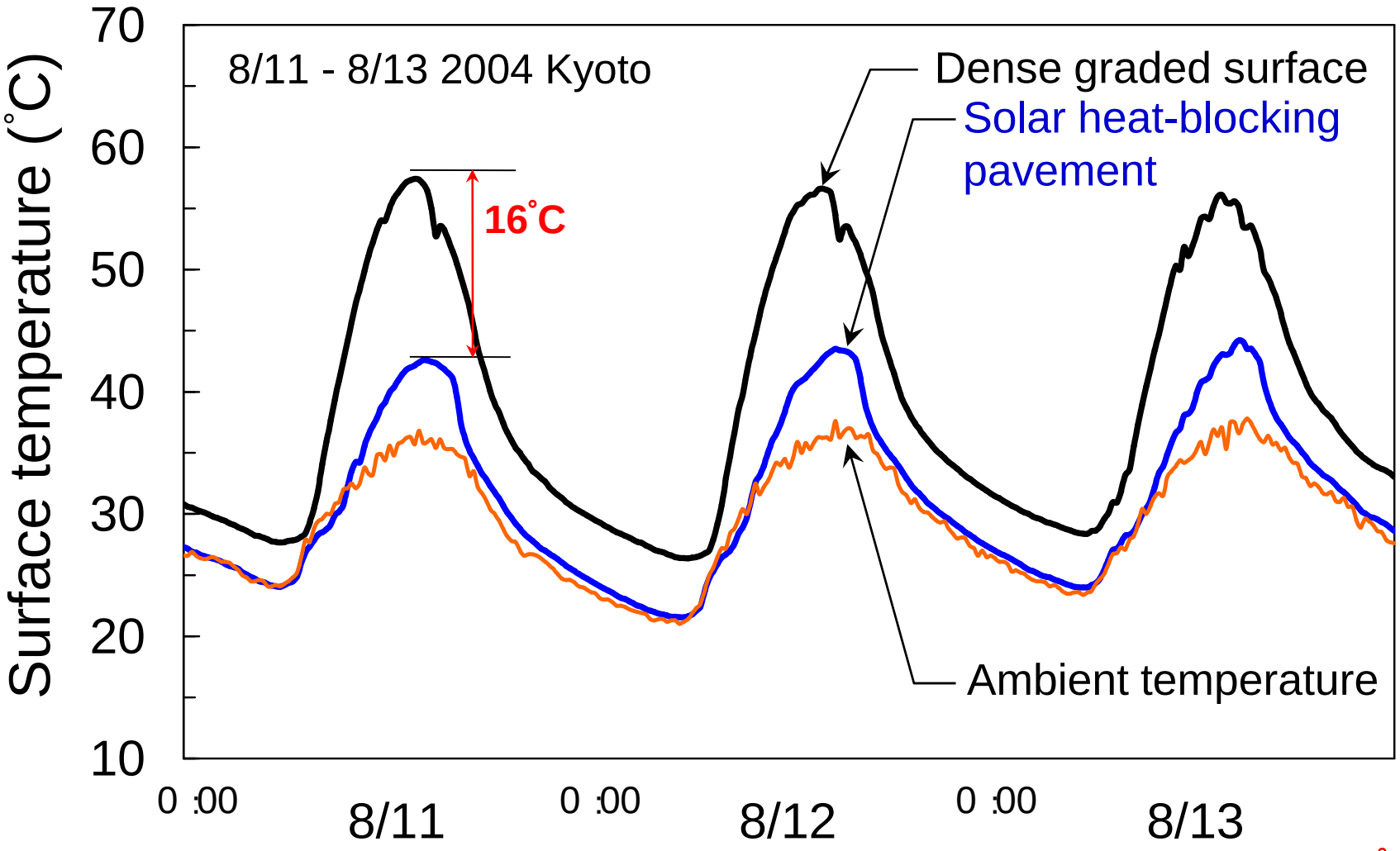
Albedo characteristics of treatment materials

Albedo: Degree of reflection



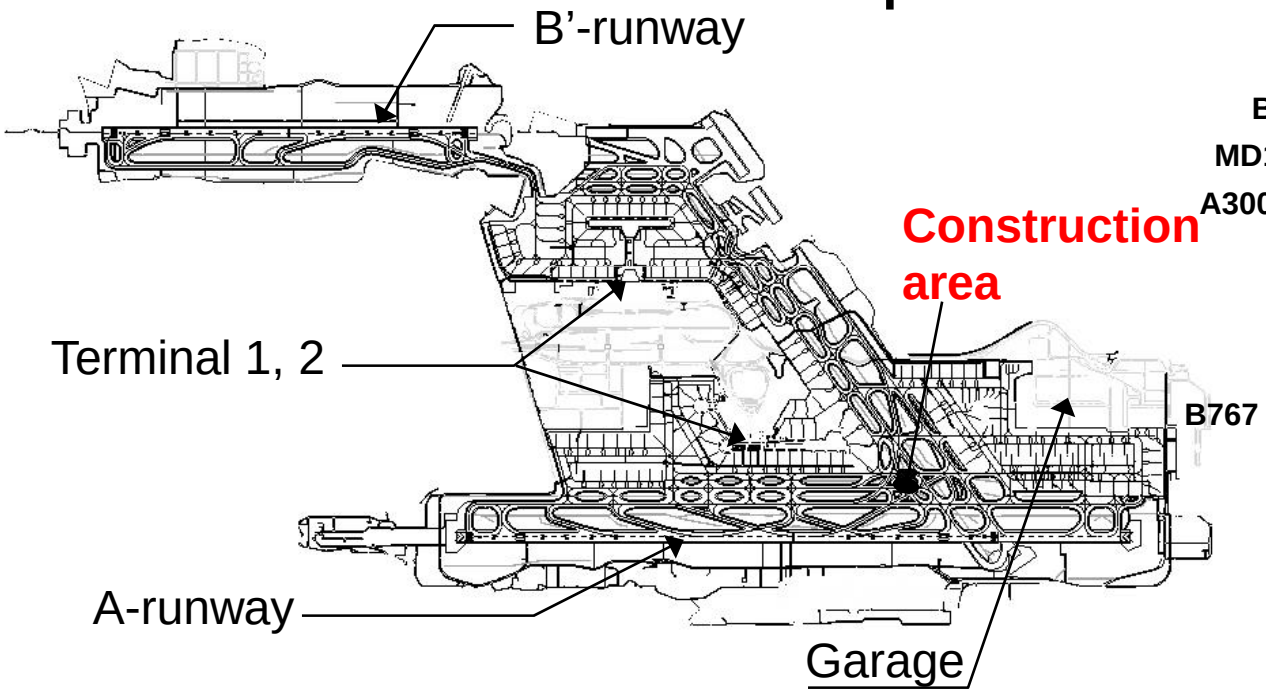
- Straight asphalt has a **very low albedo**
- Dark-gray treatment materials have a **low albedo for visible rays,** but **a very high albedo (about 90%) for near-infrared rays**

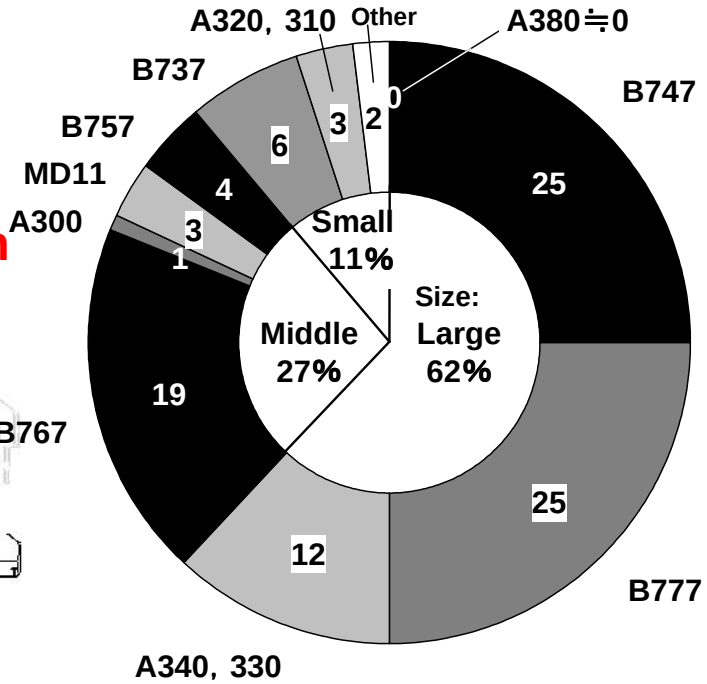
Performance of heat blocking pavement



- The maximum temperature of the conventional pavement **rose to 57.4˚C**
- The temperature of the treated surface was **reduced by about 16˚C**

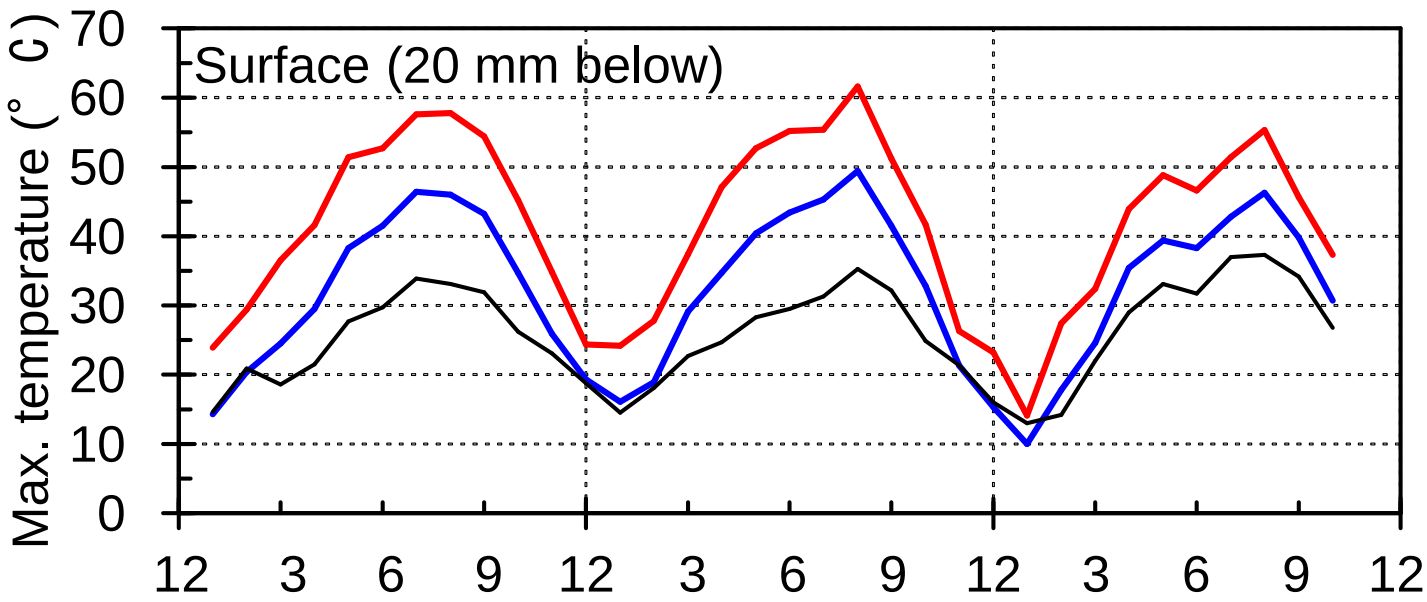
Case study
- Rutting mitigation at airport taxiway -
Narita International Airport

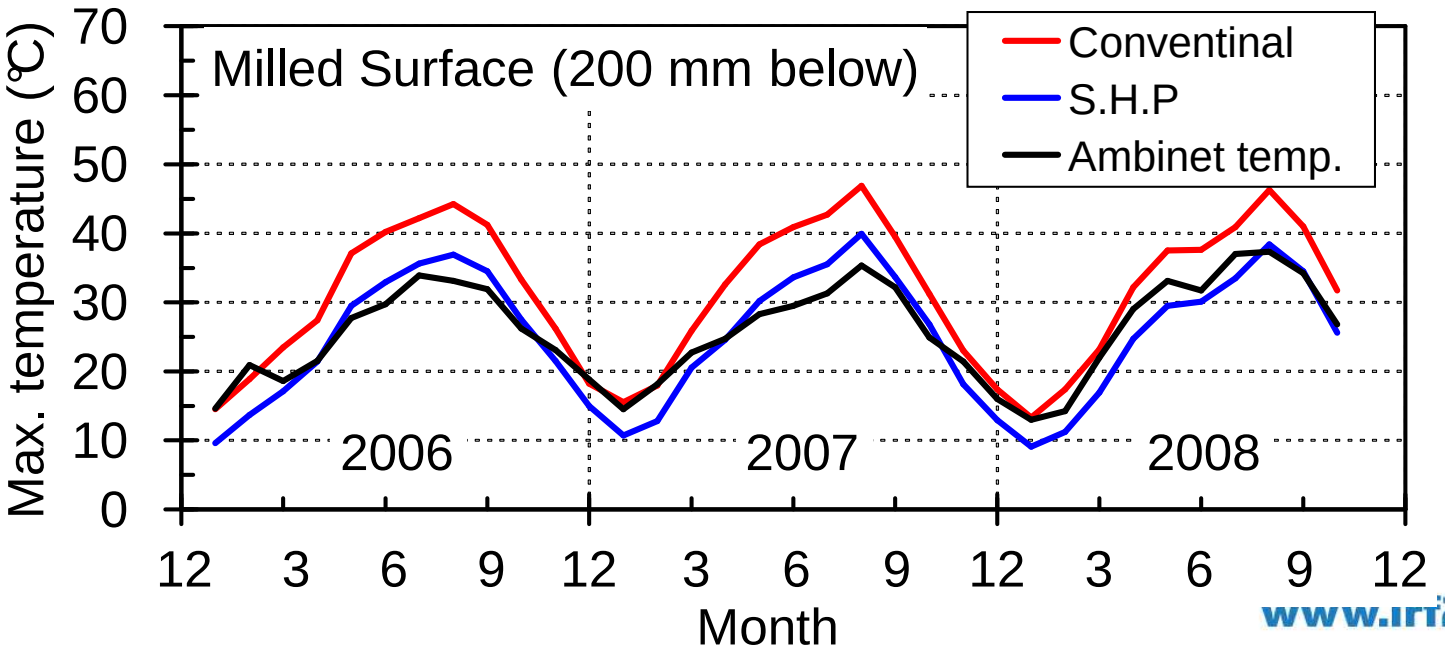




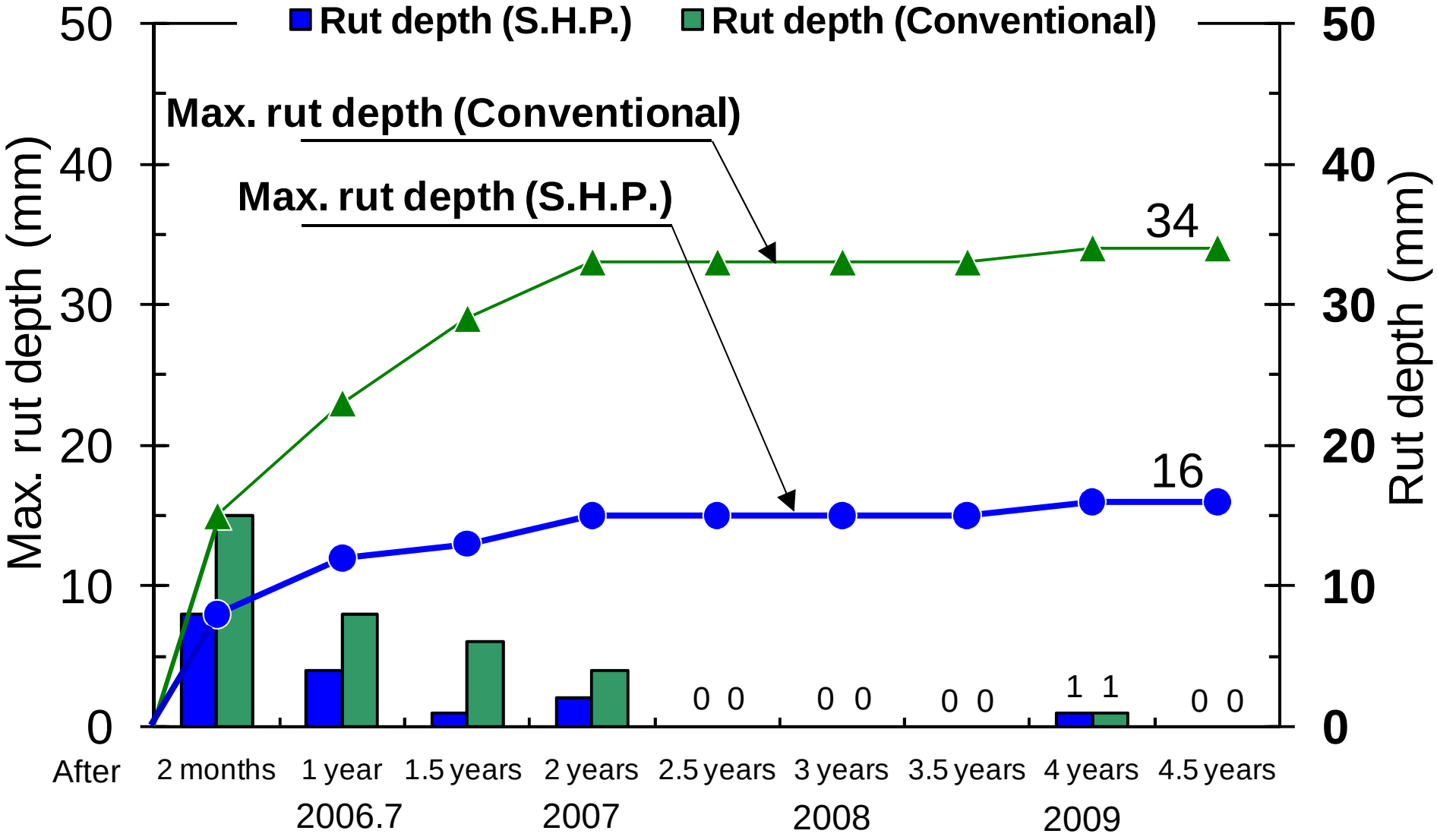
- Temperatures both in conventional surface and S.H.P. were measured at 20 mm, 80mm and 200mm below the surface

Temperature of pavements





Differences of rut depth



Conclusions

- The application of micro-forms WMA(ECOFINE) enables the production and laying temperature to be **30 °C lower** than normal bitumen.
- Approx. **50%** of CO_2 generation can be reduced by decreasing the number and size of rollers.
- The reduction in surface temperatures for the heat-blocking pavement is approximately **16 °C** .
- This technology would be effective to the **rutting** as the rate of rut depth was approximately **a half**, compared to the dense-graded asphalt surface at the taxiway .

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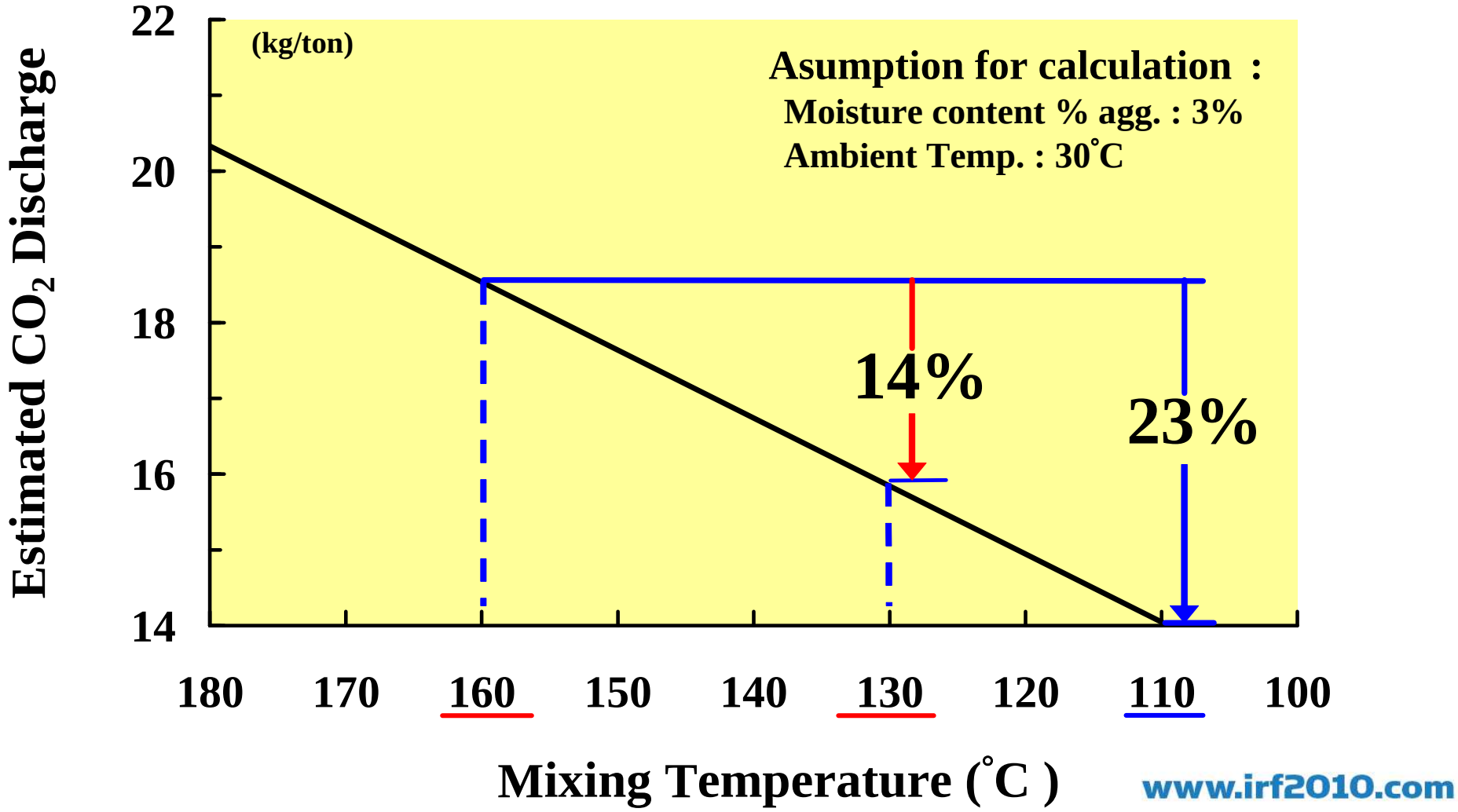
Thank you

Properties of *ECOFINE*

Estimated CO_2 emission; 30 to 50 °C reduction

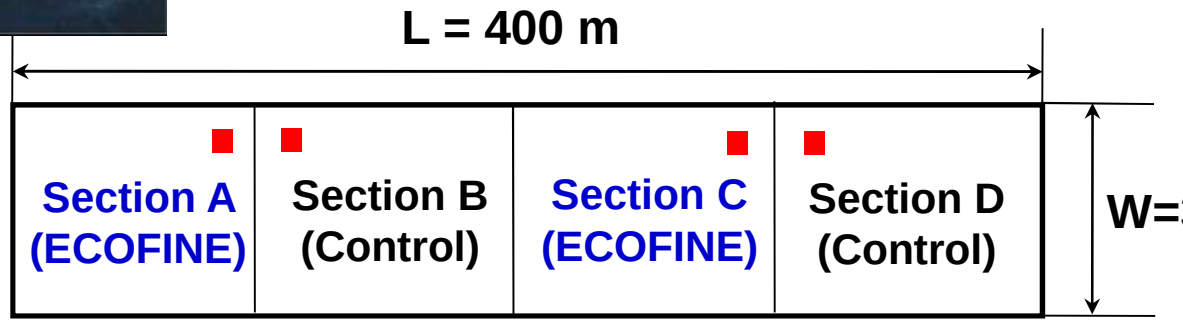


Case studies

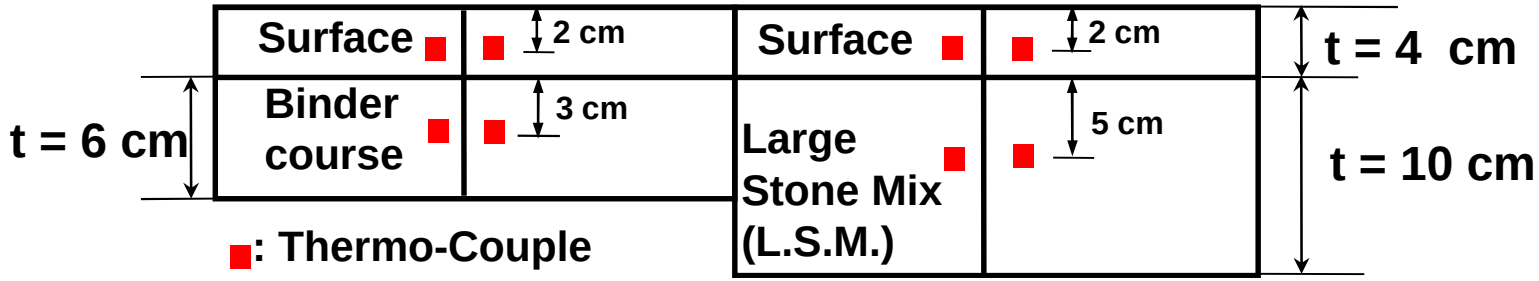
- Highway maintenance -

- Divided the maintenance area into **4** sections
- Compared construction time between Control and *ECOFINE* sections in surface, binder course and L.S.M.

Plane figure



Section



Case studies
- Highway maintenance -

Mixture / Item	Surface		Binder course		Large Stone Mix.	
	Control	***ECO FINE***	Control	***ECO FINE***	Control	***ECO FINE***
Density (g/cm^3)	2.314	2.309	2.369	2.363	2.379	2.378
Air Void (%)	5.7	5.9	4.1	4.3	4.6	4.6
Compaction Degree (%)	97.7	97.5	100	99.8	99.0	99.0

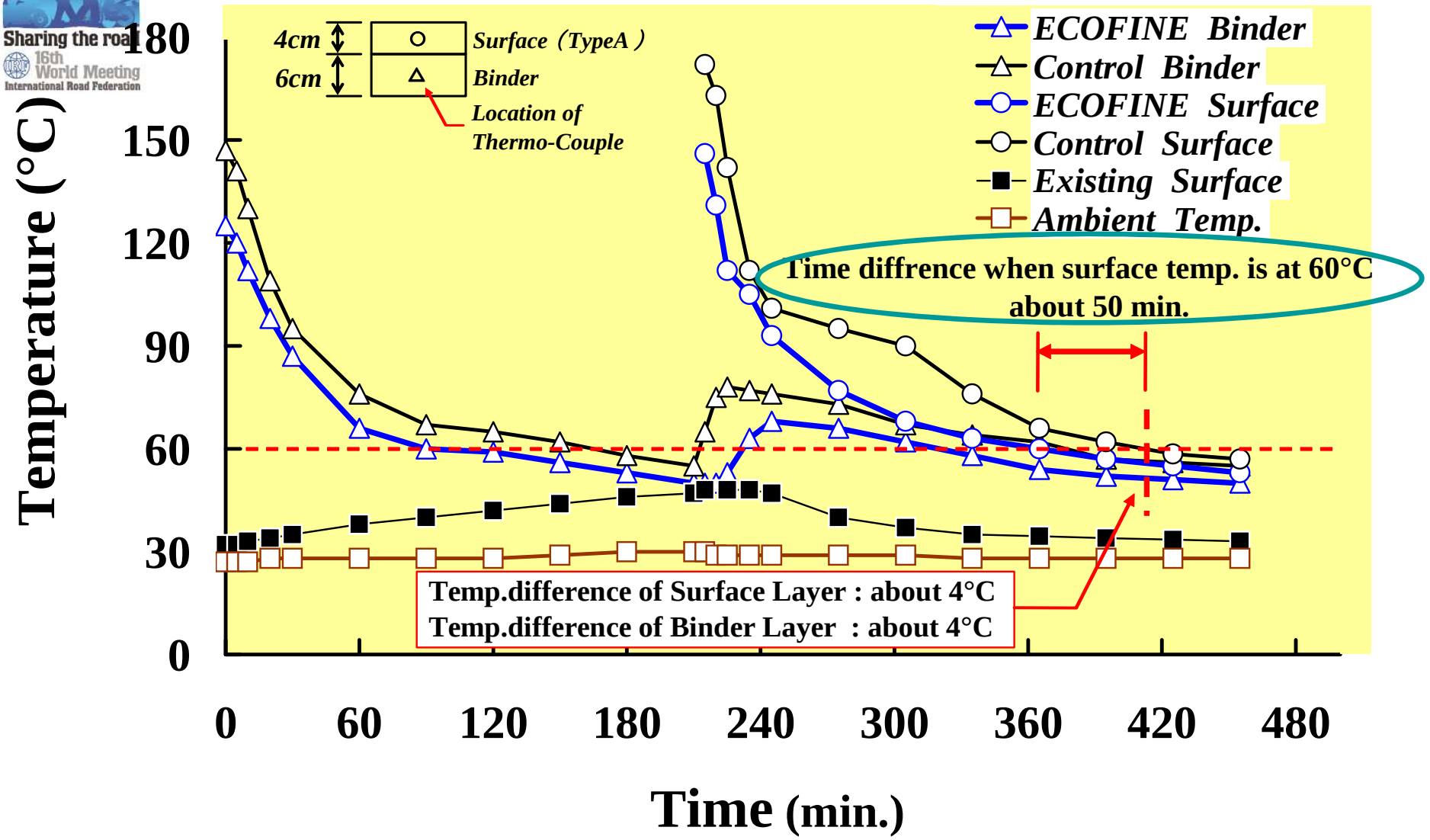
Case studies
- Highway maintenance -

Item / Section	Rut depth (mm)		Evenness (mm)		Skid resistance (BPN)	
	After construction	After 6 months	After construction	After 6 months	After construction	After 6 months
A	**1**	**1**	**0.86**	**1.03**	**70**	**72**
B	2	2	0.74	0.82	73	68
C	**1**	**1**	**0.98**	**0.84**	**72**	**70**
D	1	1	0.79	0.82	74	71

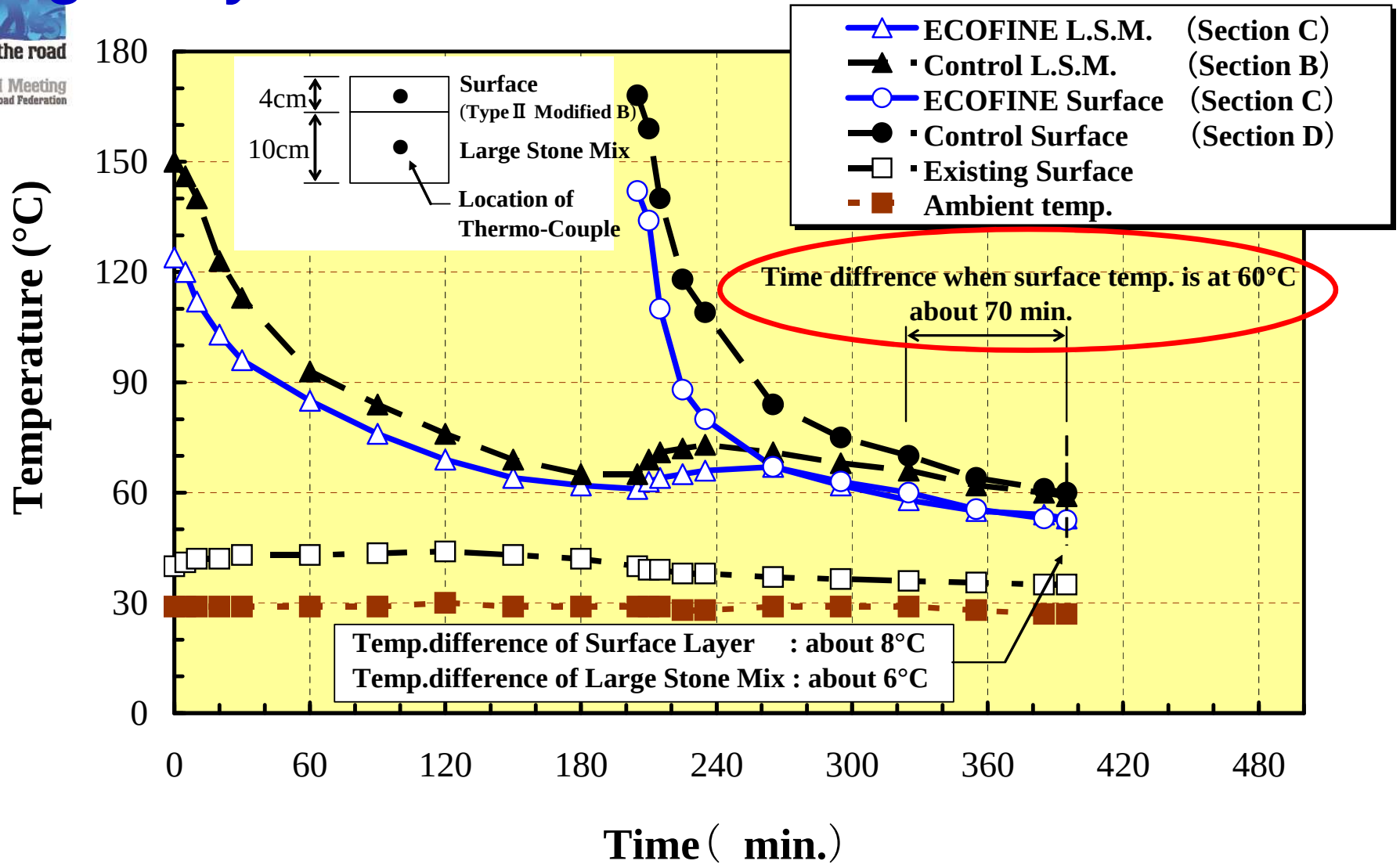
Note: Section A Surface + Binder course (*ECOFINE*) , B Surface + Binder course (Control)

Section C Surface + Large Stone Mix. (*ECOFINE*), D Surface + Large Stone Mix. (Control)

Case studies
Highway maintenance - Surface & Binder courses



Case studies
Highway maintenance - Surface & Large Stone Mix.



Environmental issues

Hotter pavement:

- leads to the urban heat island phenomenon
- may affect the heath of pedestrians due to the higher temperatures

Public demand to reduce the temperature of road pavement

Research & Development
Basic concept

Highly reflective pigment

Highly reflective for near-infrared rays

→ **Prevention of heating**

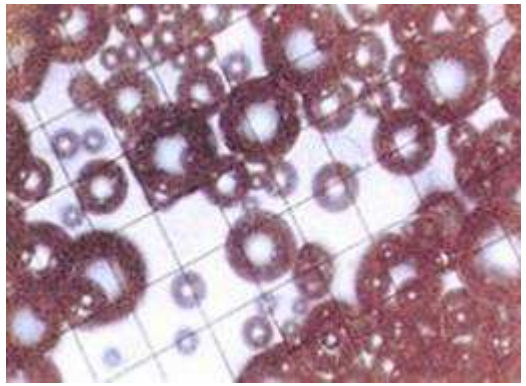
Low reflectivity for visible rays

→ **Enables various colors to be selected**

Hollow ceramic particles

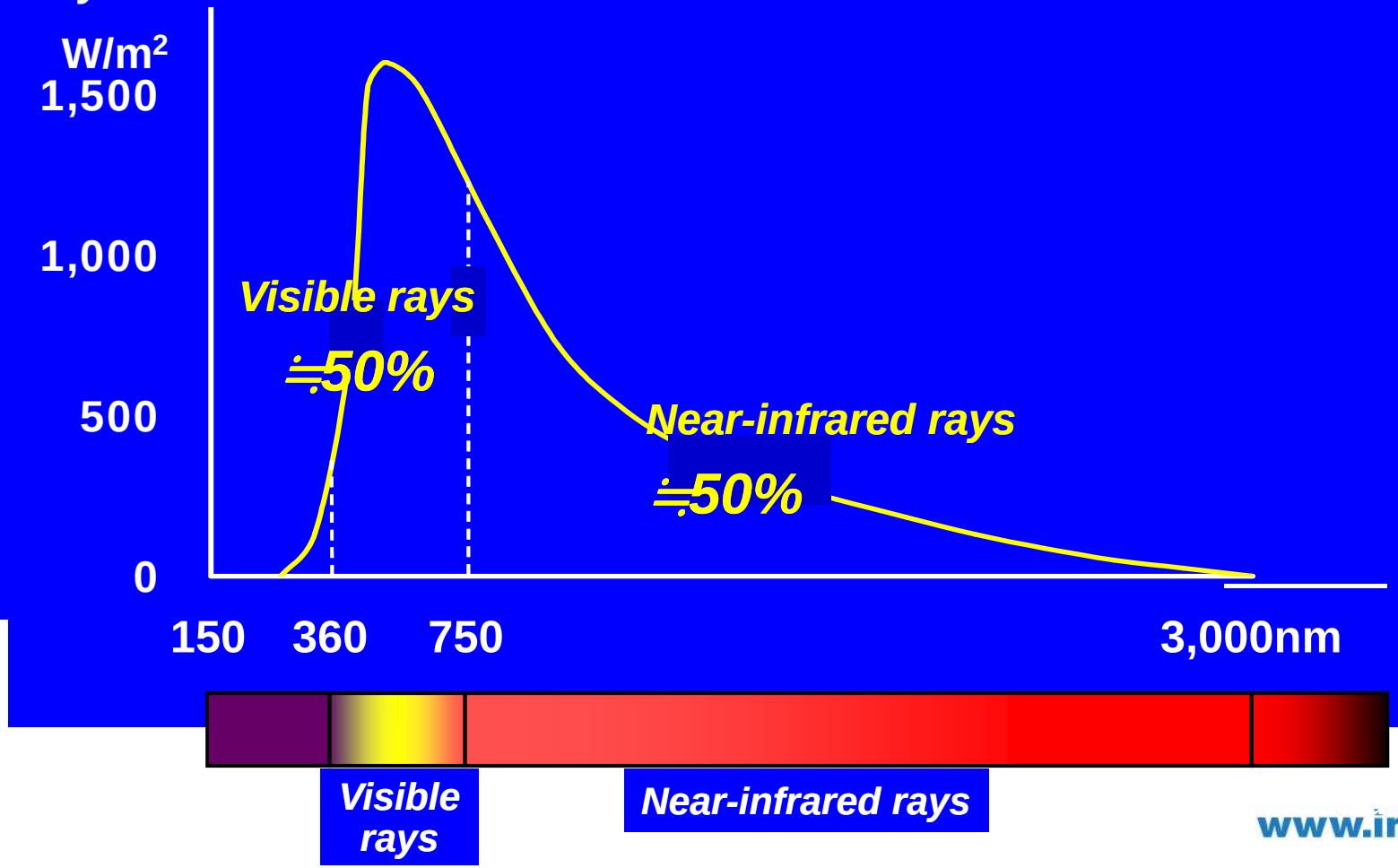
- **Reflect solar radiation to the atmosphere**

Hollow ceramic particles
（5～150μm）

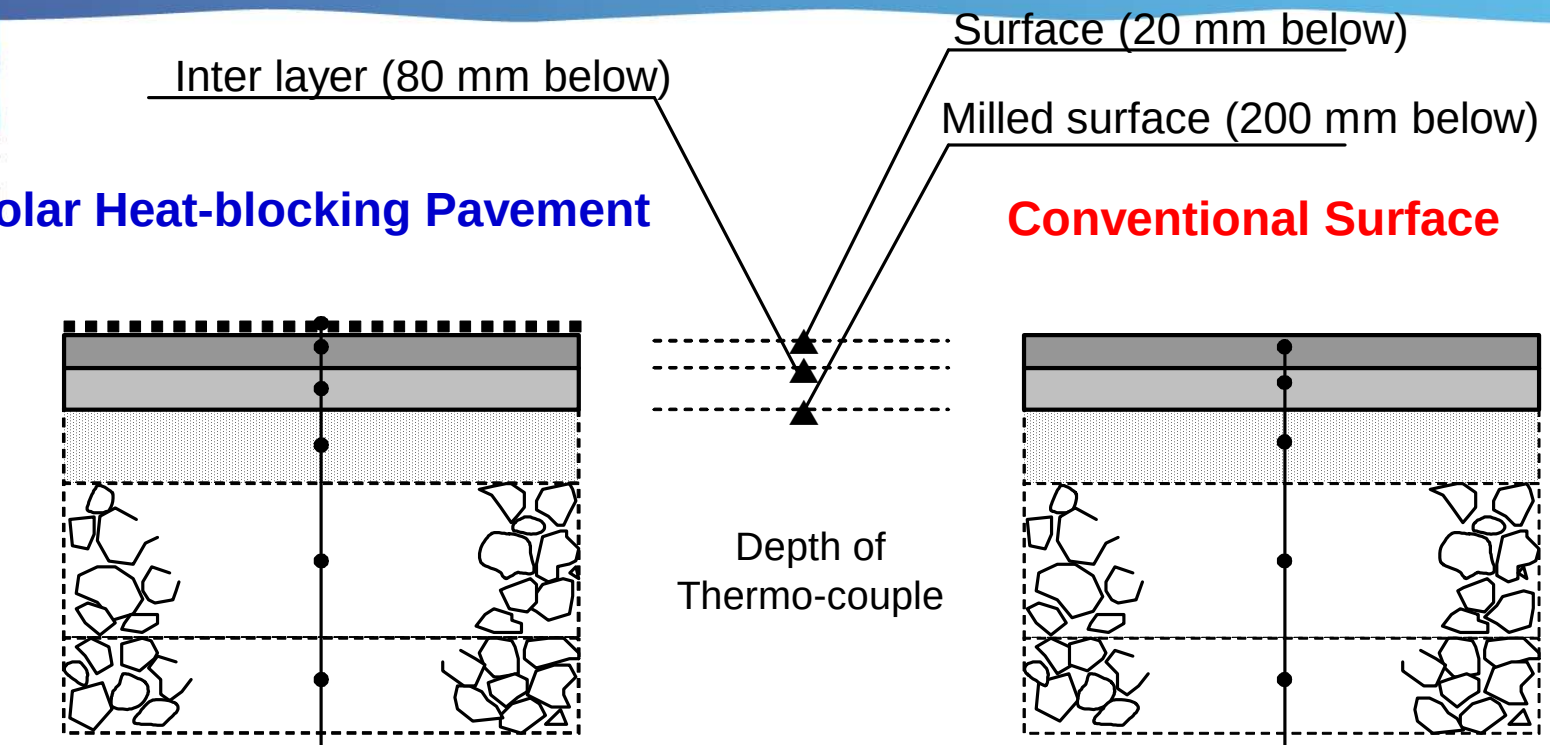


What is solar radiation?

- Solar radiation mainly consists of visible rays and near-infrared rays and includes some ultraviolet rays
- 50% of solar energy is visible rays; the rest is near-infrared rays



Section of pavements



Construction overview		
	Coated layer	
	Surface: Large stone mix. (Modified Asphalt)	t= 80 mm
	Binder course: Large stone mix. (Modified Asphalt)	t=120 mm
	Bituminous stabilization	t=200 mm
	Cement stabilization	t=500 mm
	Crusher-run	t=300 mm