Use of Solar Heat-blocking Pavement Technology for Mitigation of Urban Heat

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NIPPO

“ World climate now on the brink”

“ Dangerous warming now can’t be avoided”

Incorporating material from the Observer, Le Monde and the Washington Post

theguardian weekly

A week in the life of the world | 3-9 June 2011

World climate now ‘on the brink’

Emissions hit record high despite recession

Dangerous warming now can't be avoided

Fiona Harvey

Greenhouse gas emissions increased by a record amount last year, to the highest carbon output in history. According to unpublished estimates from the International Energy Agency, this means hopes of holding global warming to safe levels are now all but out of reach.

The rise means the goal of preventing a temperature rise of more than 2 degrees Celsius, which scientists say is the threshold for potentially “dangerous climate change”, is likely to be just “a nice Utopia”, according to Fatih Birol, chief economist of the IEA. It also shows that the most serious global recession for 80 years has had only a minimal effect on emissions.

Last year, a record 30.6 gigatonnes of carbon dioxide poured into the atmosphere, mainly from burning fossil fuel, a rise of 1.6Gt on 2009, according to estimates from the IEA. These are the gold standard for such data.

“I am very worried. This is the worst news on emissions,” Birol said. “It is becoming extremely challenging to remain below 2 degrees. The prospect is getting bleaker.”

Professor Nicholas Stern of the London School of Economics, the author of an influential 2006 report into the economics of climate change, warned that if the pattern continued, the results would be dire.

“These figures indicate that [emissions] are now close to being back on a business as usual path. According to the [Intergovernmental Panel on Climate Change’s] projections, such a path ... would mean around a 50% chance of a rise in global average temperature of more than 4C by 2100. Such warming would disrupt the lives and livelihoods of hundreds of millions of people across the planet, leading to widespread mass migration and conflict. That is a risk any sane person would seek to drastically reduce.”

Birol said disaster could yet be averted, if governments heed the warning. “If we have bold, decisive and urgent action, very soon, we still have a chance of succeeding.”

The IEA has calculated that if the world is to escape the most damaging effects, annual energy-related emissions should be no more than 32Gt by 2020. If this year’s emissions rise by as much as 2010’s, that limit will be exceeded nine years ahead of schedule, making it all but impossible to hold warming to a manageable degree.

Emissions from energy fell slightly between 2008 and 2009, from 29.3Gt to 29Gt, because of the financial crisis. A small rise was predicted for 2010 as economies recovered, but the scale of the increase has shocked the IEA. “I was expecting a rebound, but not such a strong one,” said Birol, regarded as one of the world’s foremost experts.

John Sauven, executive director of Greenpeace UK, said time was running out. “This news should shock the world. Yet even now politicians in the great powers are eyeing up extraordinary, risky ways to extract the world’s last remaining reserves of fossil fuels, even from under the melting ice of the Arctic. You don’t put out a fire with gasoline. It will now be up to us to stop them.”

About Continued on page 23

Worse and worse ... flight from nuclear power will lead to more fossil fuel emissions David Reede/Corbis

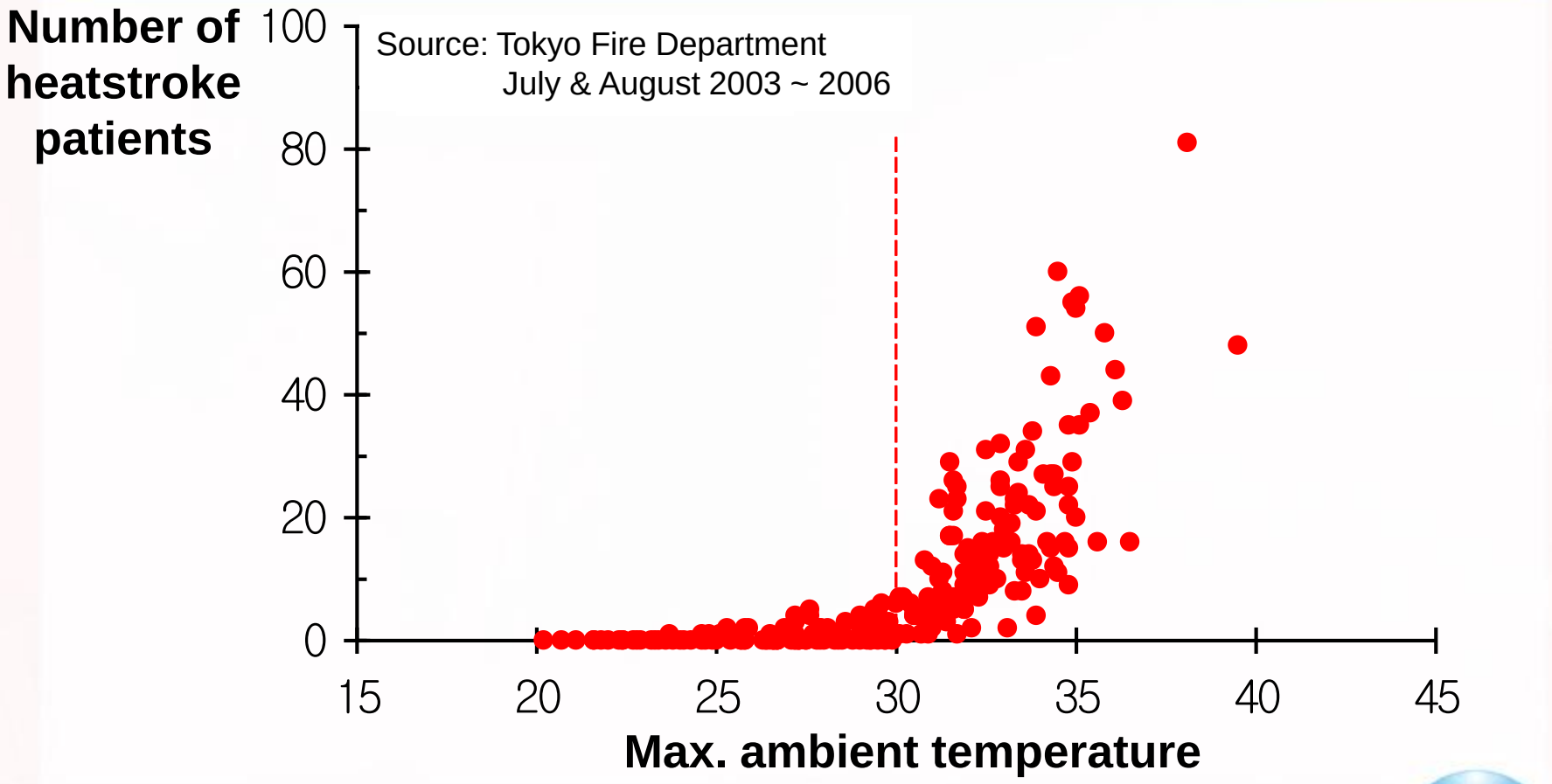
http://earthobservatory.nasa.gov/Features/GreenRoof/

Outline of Presentation

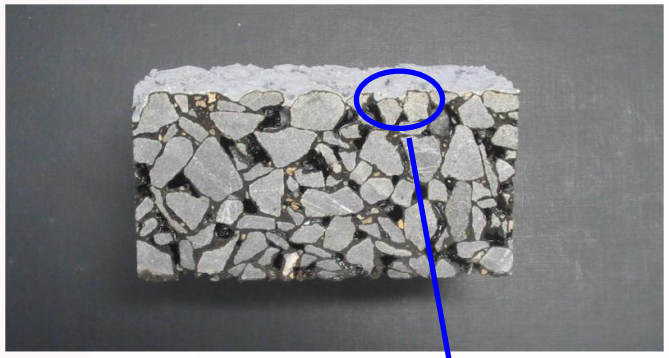
- Background & Solar Heat-blocking Pavement
- Mitigation of Urban Heat Islands
- Reduction in Rutting
- Conclusions

Background
&
Solar Heat-blocking Pavement

Increase in patients suffering heatstroke



Basic concept

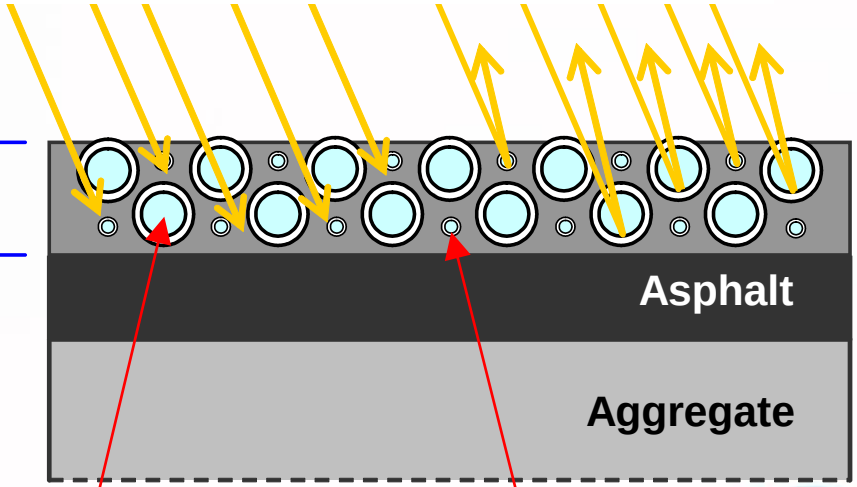


Solar radiation

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

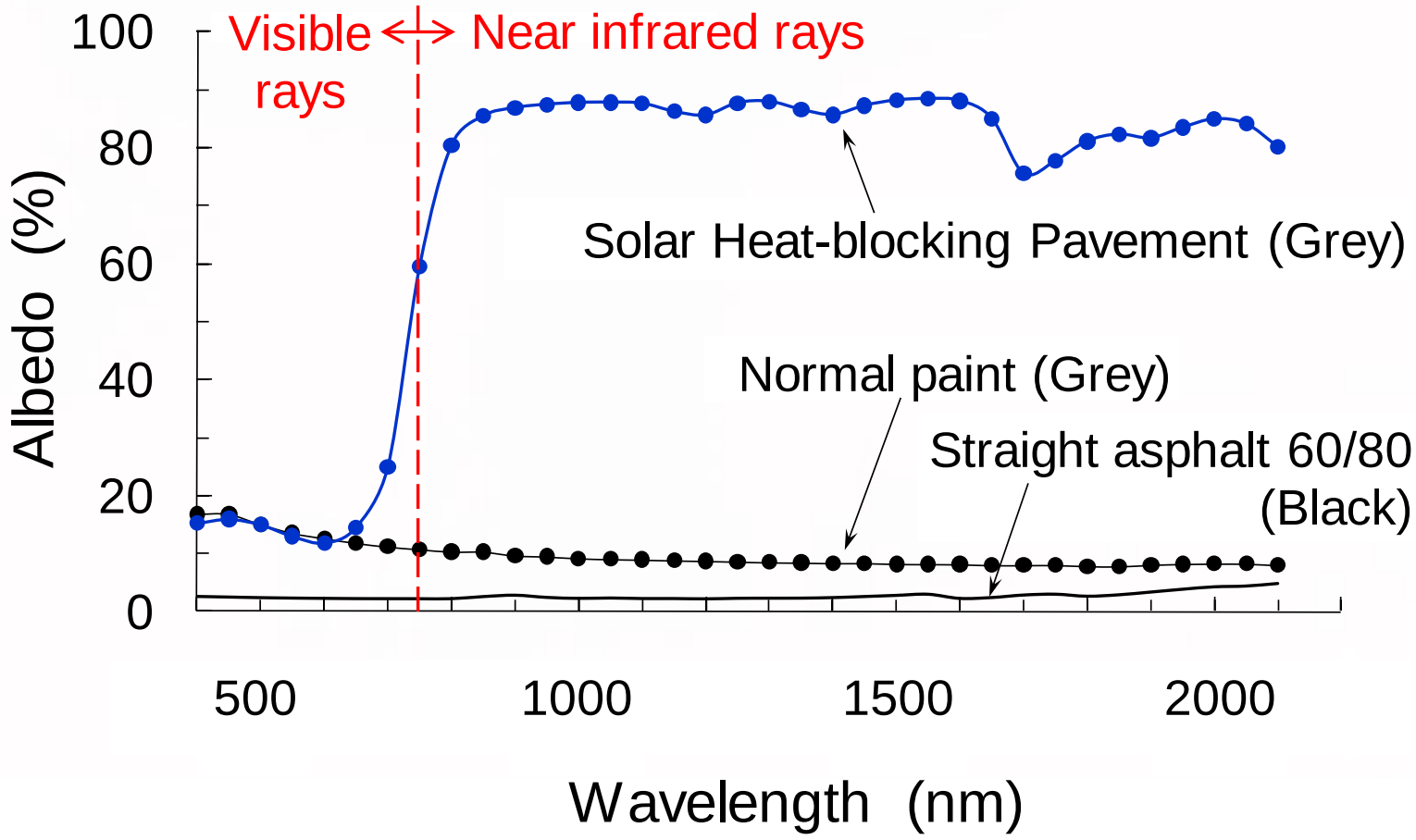
Apply high albedo and dark colored thin treatment materials

Component of hot mix asphalt



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

Albedo characteristics



- 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**

Mitigation of Urban Heat Islands

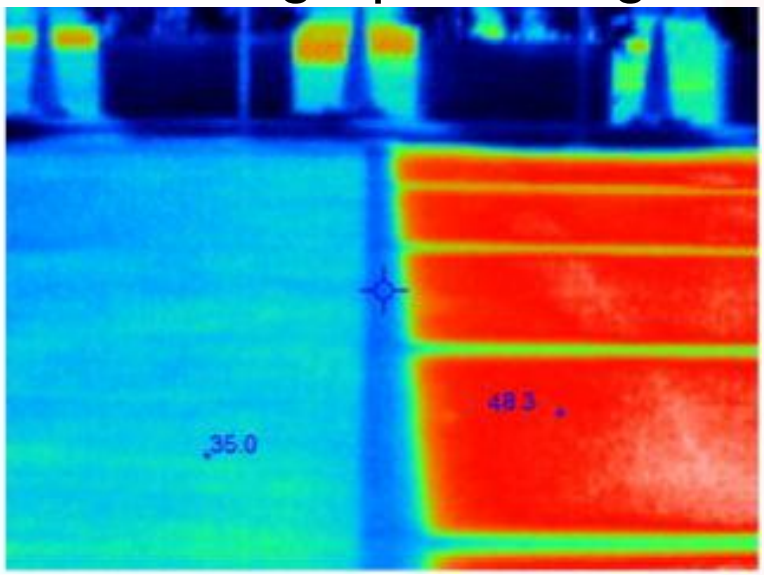
Thermal sensation - Surface temperature -

Original Image

Solar Heat-blocking Pavement

Conventional

Thermographic Image



Solar Heat-blocking Pavement

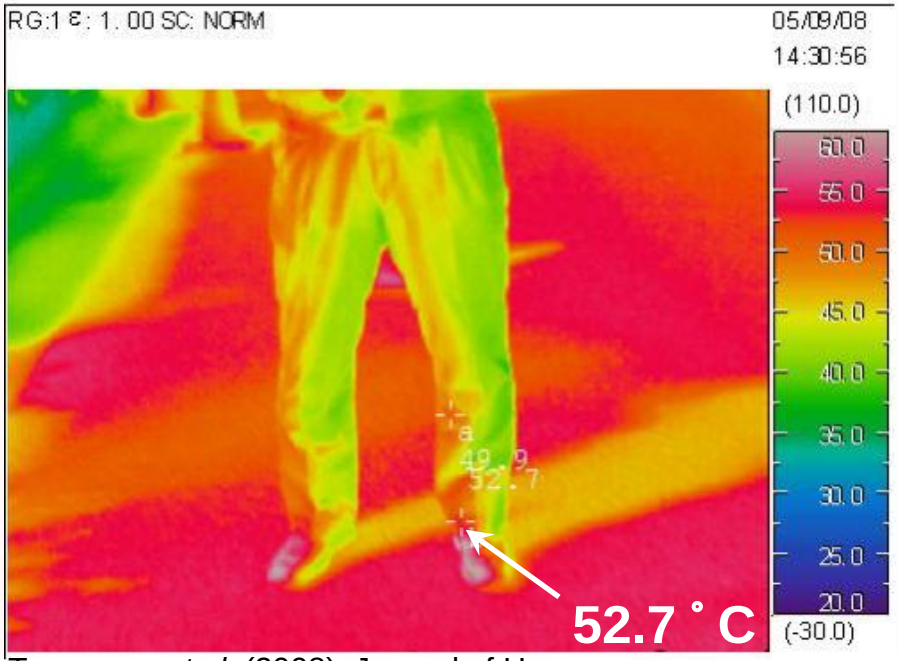
35.0 ˚ C

Conventional

48.3 ˚ C

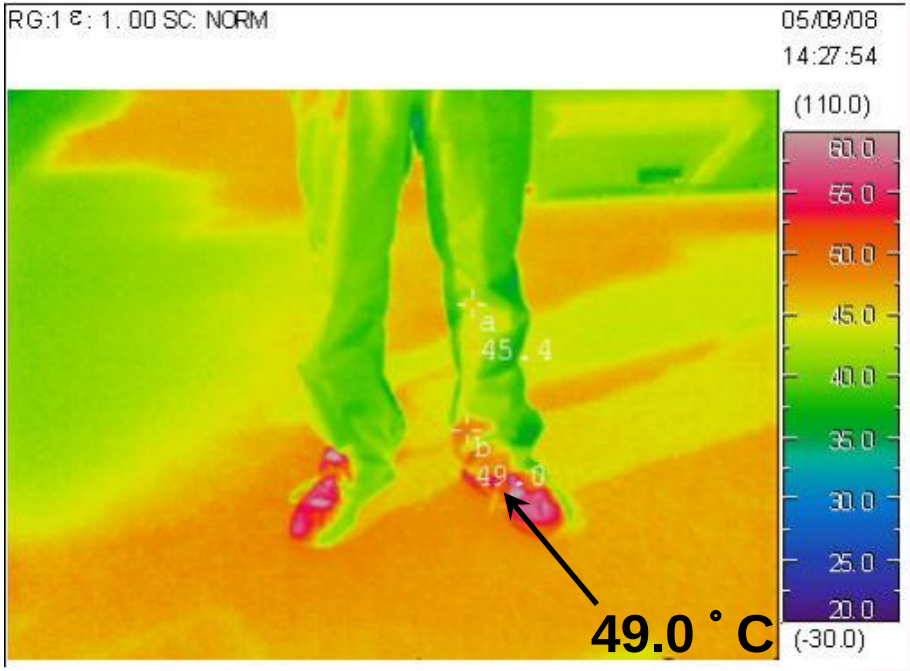
Thermal sensation - Temperature around feet-

Porous asphalt pavement



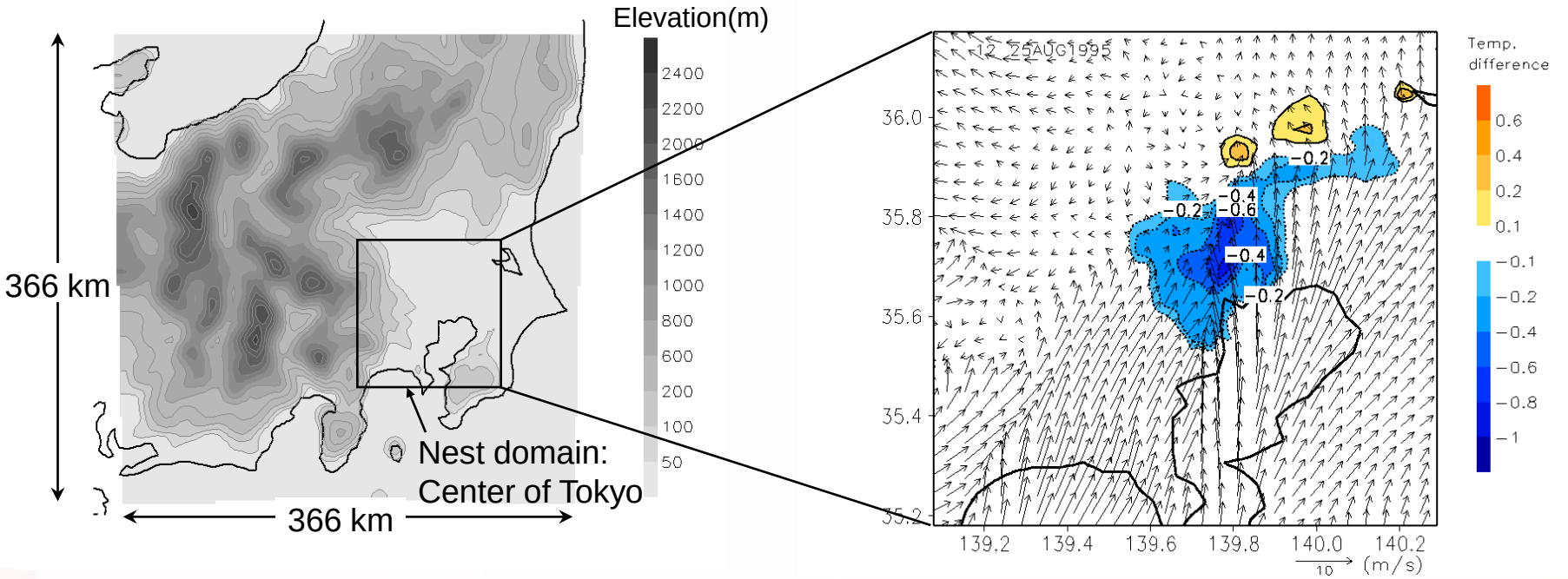
Tomonaga *et al.* (2008): Journal of Hoso, Vol. 43, No. 6, pp. 31~36

Solar Heat-blocking Pavement



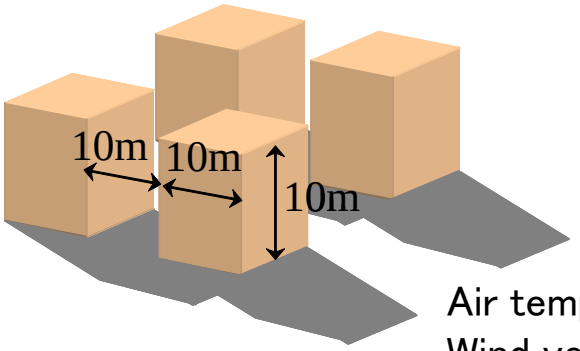
- Tomonaga *et al.* concluded that S.H.P. can improve thermal comfort around our feet

Environmental effect

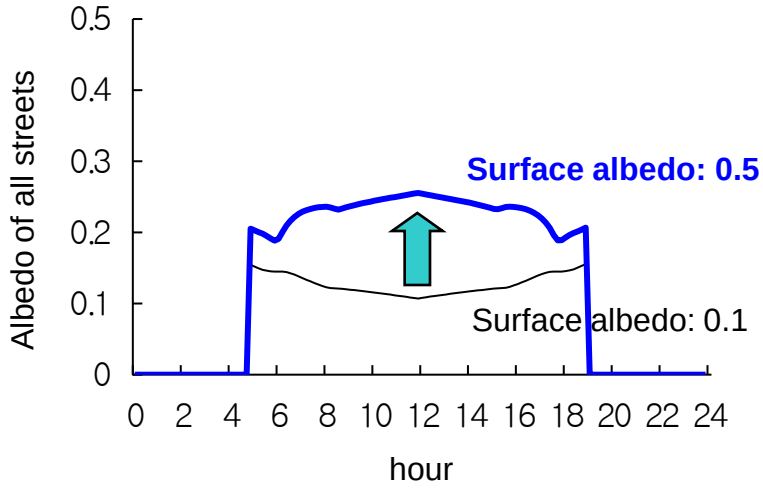


- The result indicates that air temperatures in central Tokyo would tend to decrease. Also, air temperature can be reduced by more than 0.8° C.

Effect of Reduction in Atmospheric Warming in the Streets



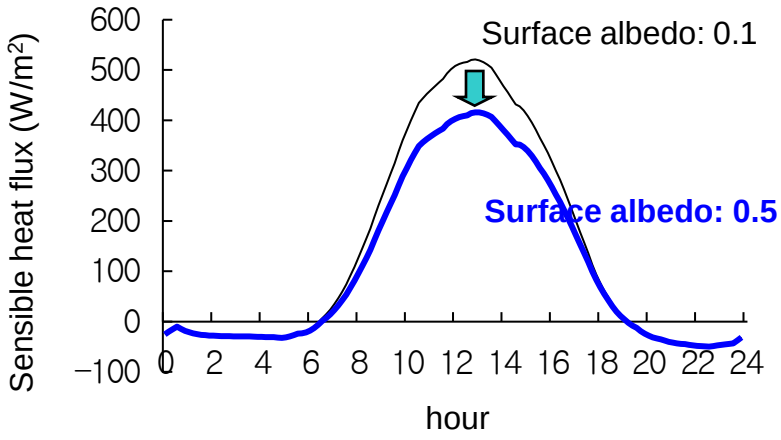
Air temperature (z=50 m): 35℃
Wind velocity (z=50 m): 5 m/s
Surface albedo: 0.1, 0.5



Change in albedo of all streets with time

Results

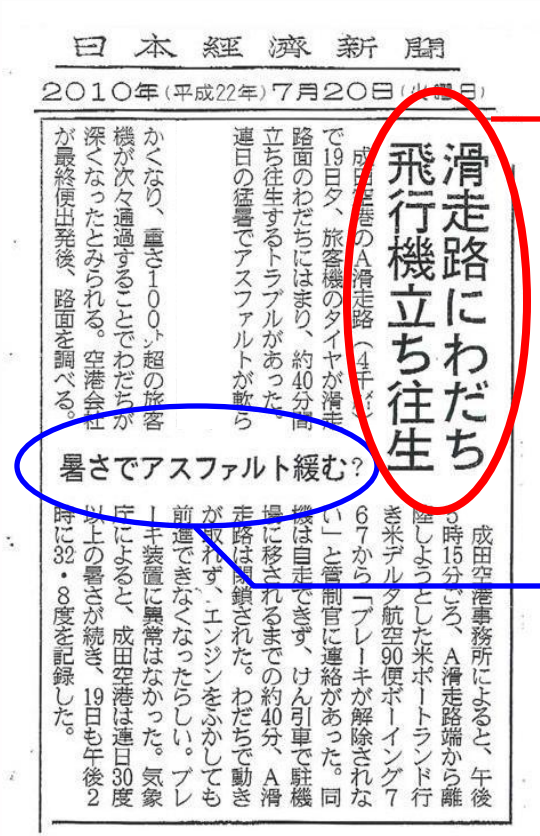
- The amount of sensible heat in the streets, which heats the atmosphere, decreased due to the increased reflectivity.
- The reduction in air temperature in the streets improves the urban heat environment.



Sensible heat flux from all streets

Reduction in Rutting

Newspaper article



日本経済新聞

2010年(平成22年)7月20日(火曜日)

滑走路にわだち
飛行機立ち往生

成田空港のA滑走路（4千メ
で19日夕、旅客機のタイヤが滑走
路面のわだちにはまり、約40分間
立ち往生するトラブルがあった。
連日の猛暑でアスファルトが軟ら
かくなり、重さ100トン超の旅客
機が次々通過することでわだちが
深くなったとみられる。空港会社
が最終便出発後、路面を調べる。

暑さでアスファルト緩む？

成田空港事務所によると、午後
5時15分ごろ、A滑走路端から離
陸しようとした米ポートランド行
き米デルタ航空90便ボーイング7
67から「ブレーキが解除されな
い」と管制官に連絡があった。同
機は自走できず、けん引車で駐機
場に移されるまでの約40分、A滑
走路は閉鎖された。わだちで動き
が取れず、エンジンをふかしても
前進できなくなったらしい。ブレ
ーキ装置に異常はなかった。気象
庁によると、成田空港は連日30度
以上の暑さが続き、19日も午後2
時に32・8度を記録した。

From the Nihon Keizai Shimbun – a Japanese national newspaper 20th July 2010

“ An airplane got stuck on the runway due to rutting ”

“Did the asphalt surface soften so much due to the heat?”

Case study - Airport taxiway -

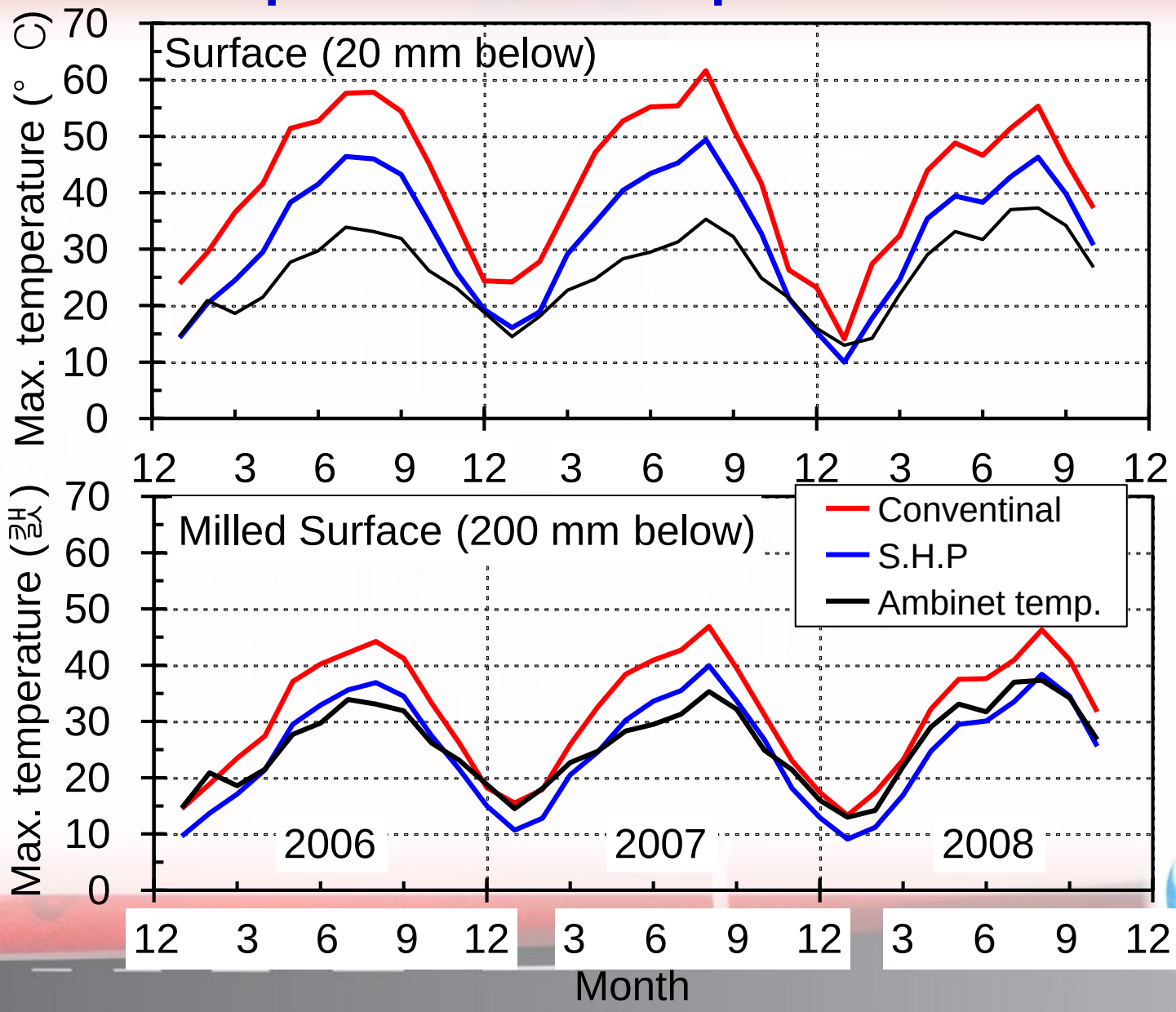
- A reduction in rut depth was expected by utilizing the solar heat-blocking pavement technology
- Solar heat-blocking material was sprayed onto the existing taxiway at an International Airport
- The rut depth was measured at five stages; after construction, 1 year, 1.5 years, 2 years and 3 years

Conventional pavement

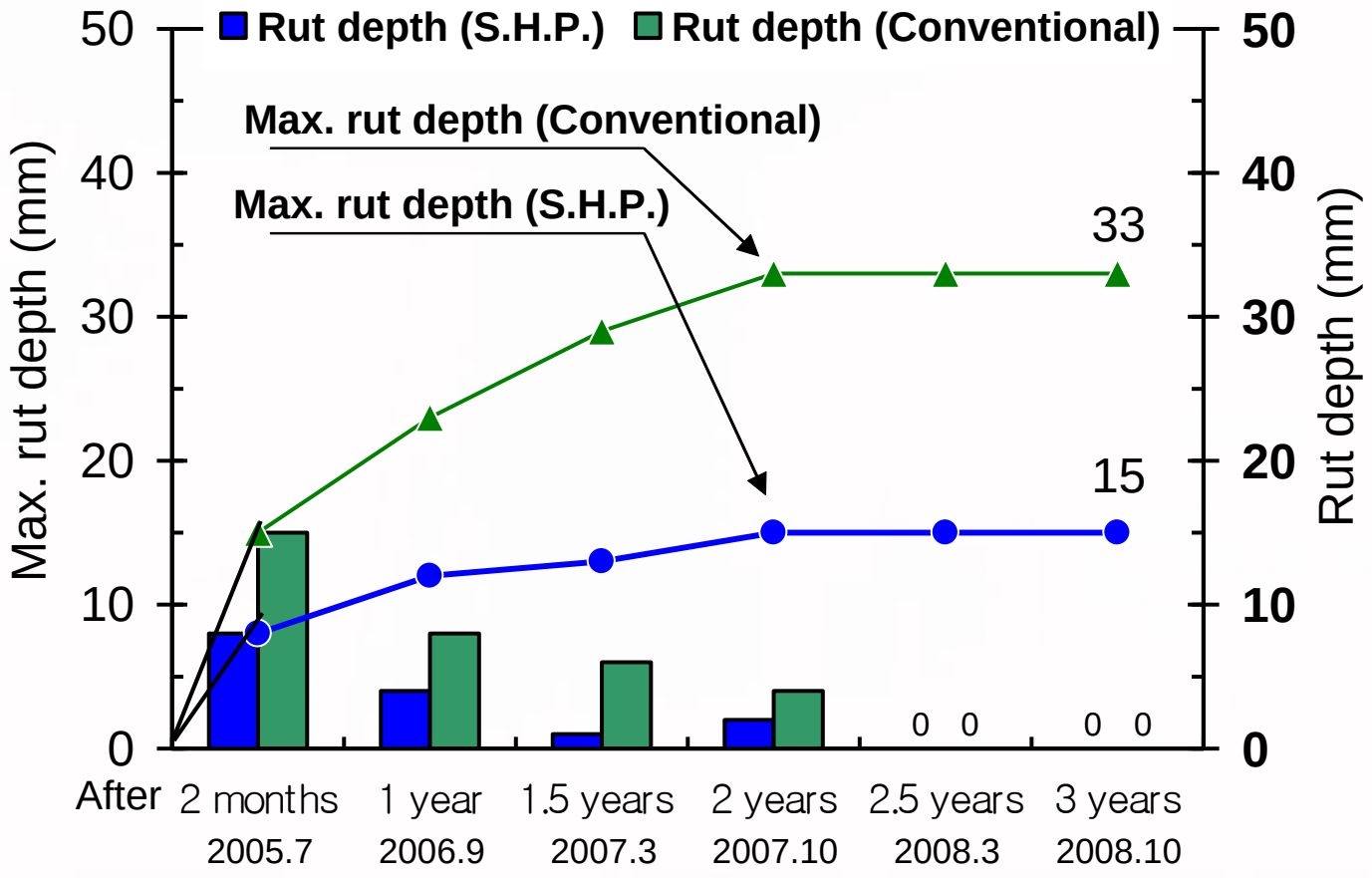
Solar Heat-blocking Pavement

Construction area

Temperature of pavements



Differences of rut depth



- Solar Heat-blocking Pavement can reduce the maximum rut depth **by half**, compared to that of conventional pavement

Conclusions

- Contributes to improved thermal sensation around pedestrian's feet.
- Solar heat-blocking pavement is likely to be useful in mitigating the "urban heat island" effect.
- This technology can effectively reduce rutting, as the rate was approximately half compared to that of dense-graded asphalt surfaces.

Thank you

Environmental issues

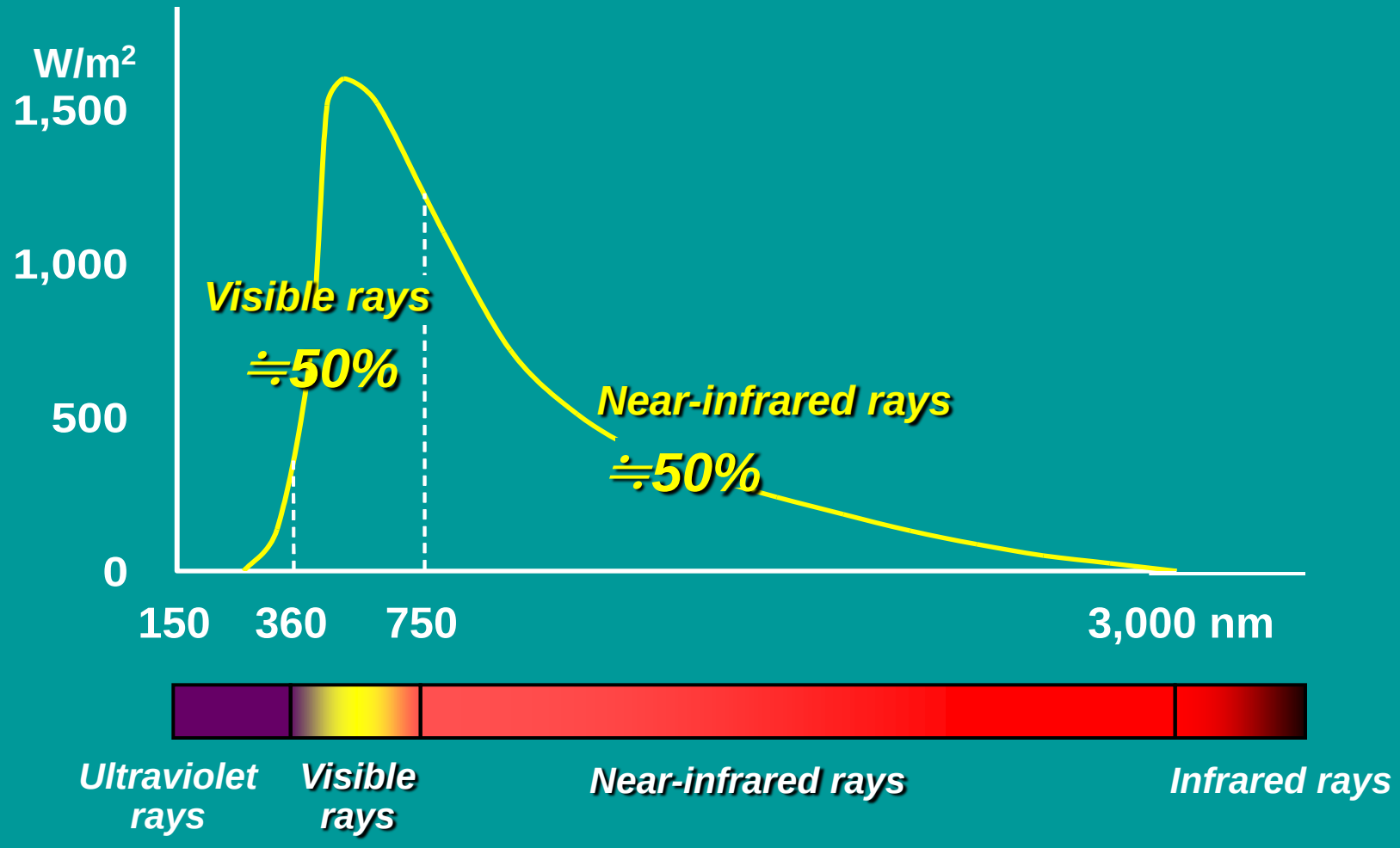
Hotter pavement:

- leads to the "***urban heat island***" phenomenon
- higher temperatures may affect pedestrians' health

Public demand to reduce the temperature of road surfaces

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.



Basic concept

Highly reflective pigment

Highly reflective for near-infrared rays

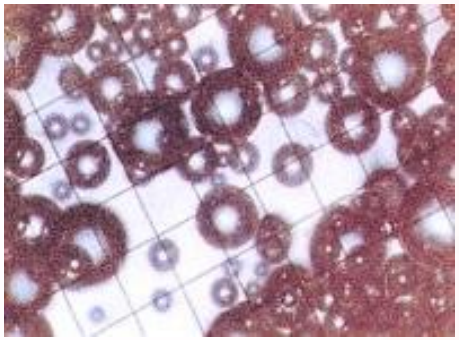
→ **Prevention of heating**

Low reflectivity for visible rays

→ **Enables various colors to be selected**

Hollow ceramic particles

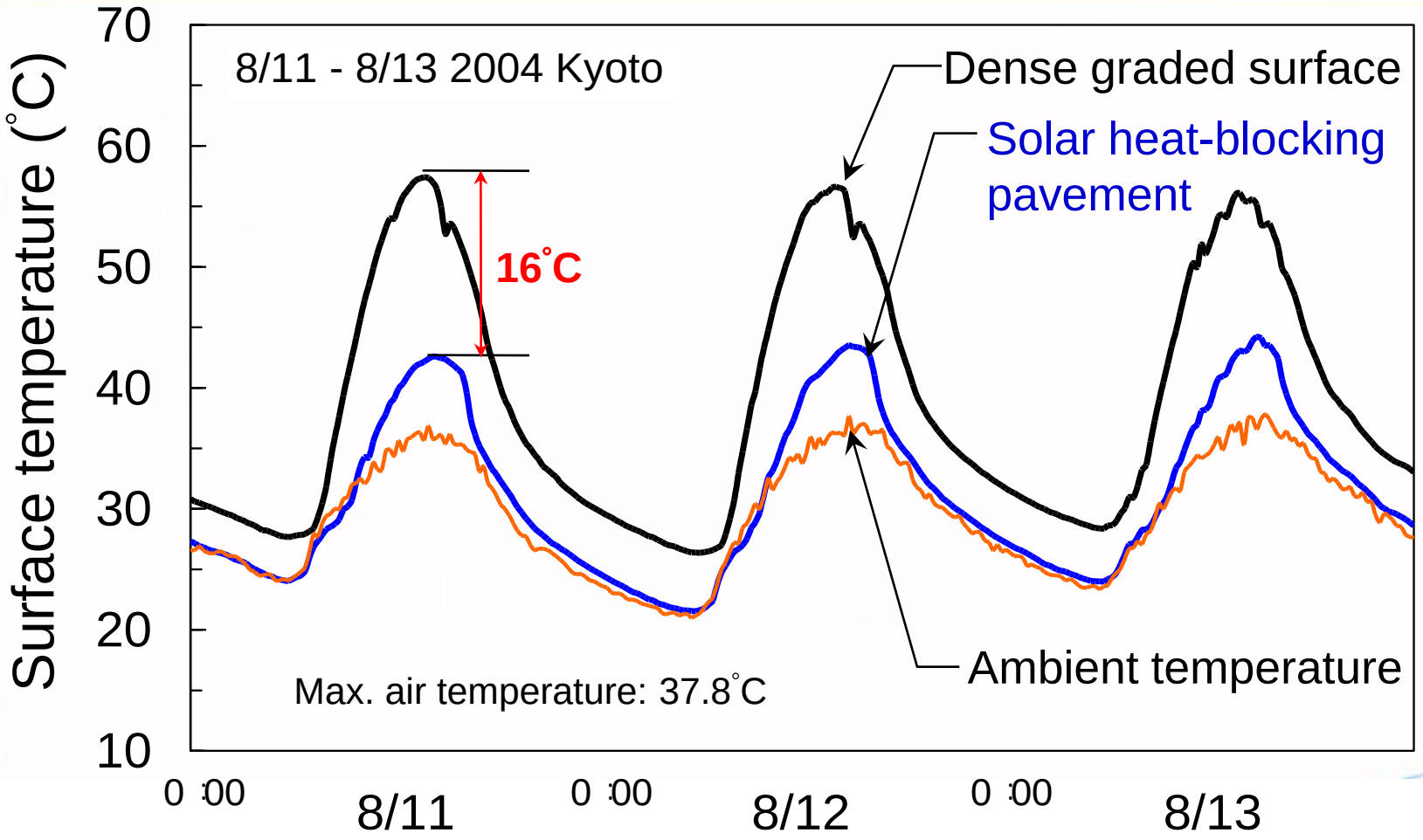
- **Reflects solar radiation back into the atmosphere**



Hollow ceramic particles

(5~150 μm)

Effect of temperature reduction

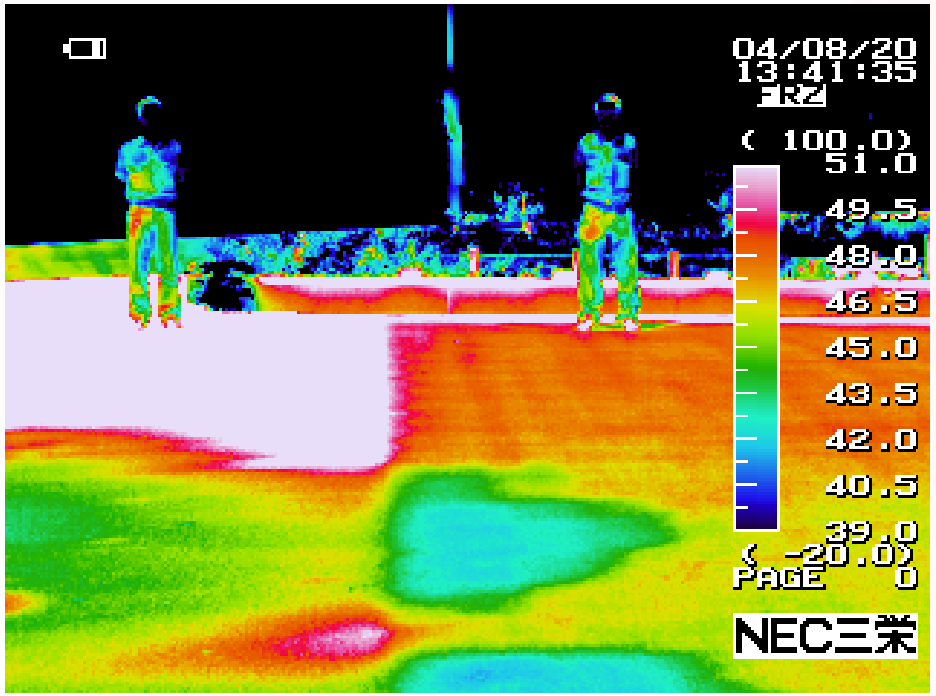


- The maximum temperature of the conventional pavement **rose to 57.4˚C**
- The temperature of the treated surface was **reduced by about 16˚C**

Influence of Thermal Impact

Use of Thermography

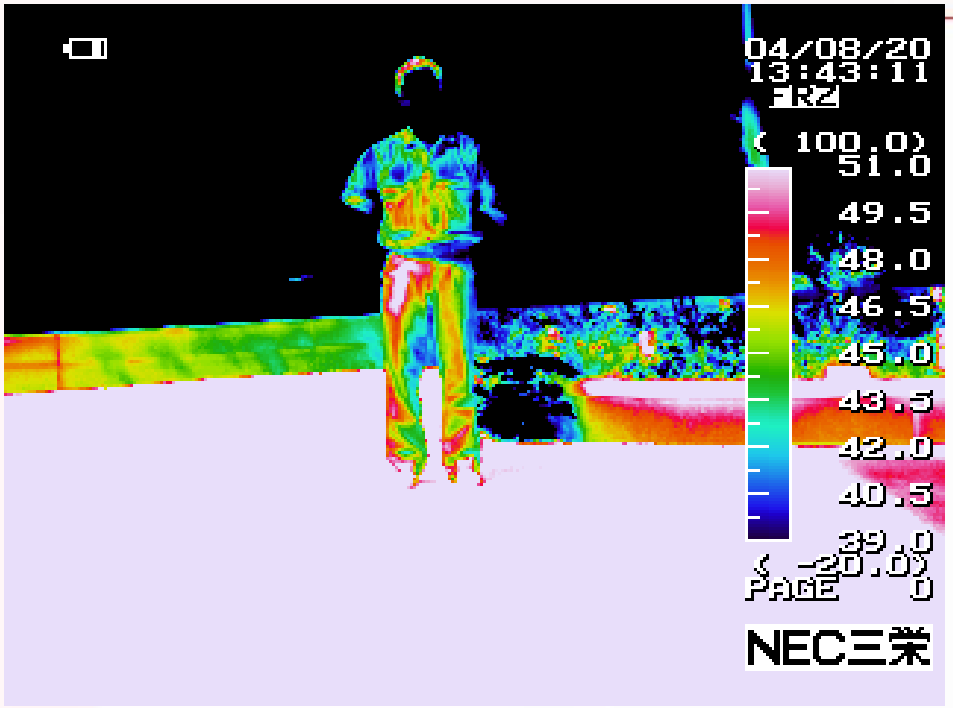
Original Picture



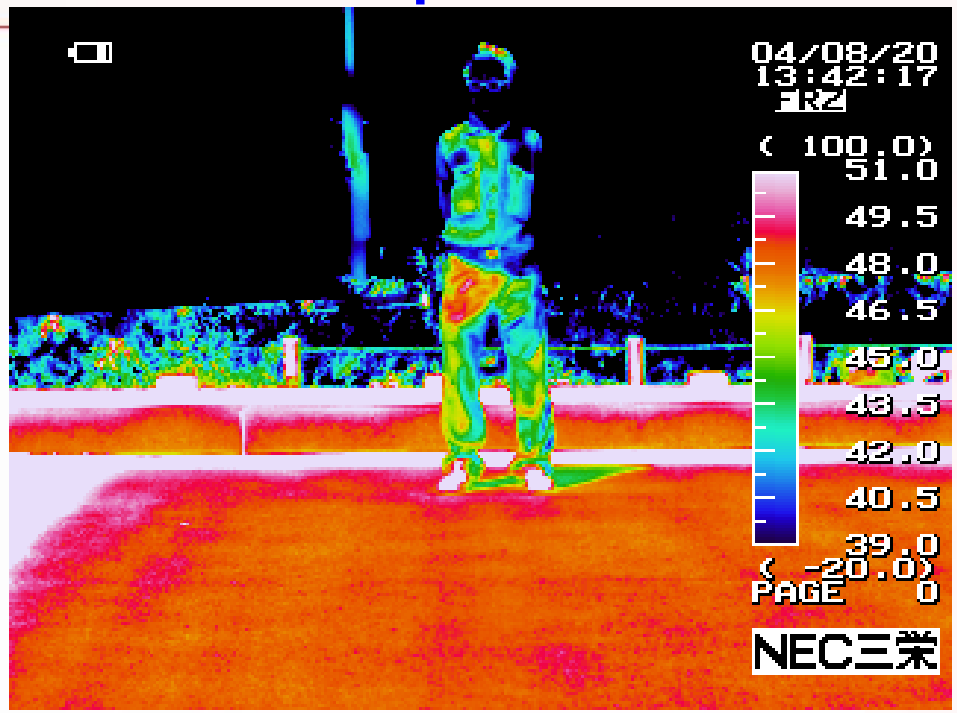
Thermographic image

- Thermography shows clear differences between Porous Asphalt Pavement and Solar Heat-blocking Pavement

Influence of Thermal Impact



Porous asphalt pavement

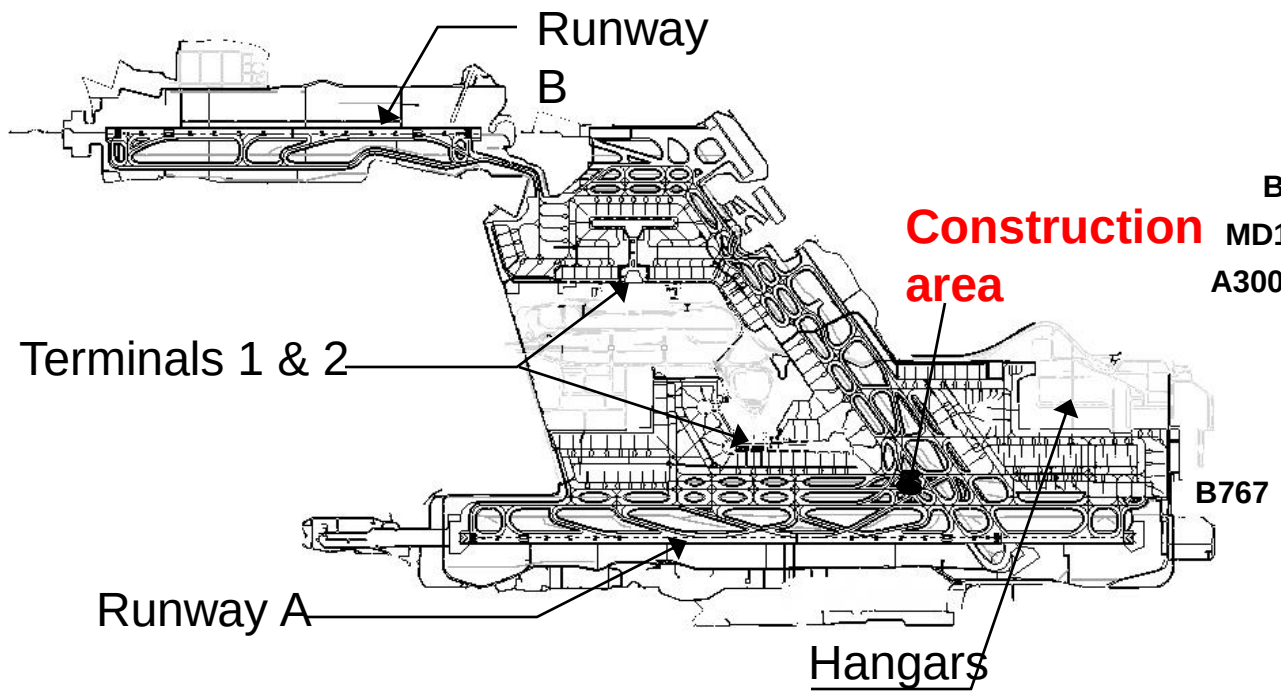


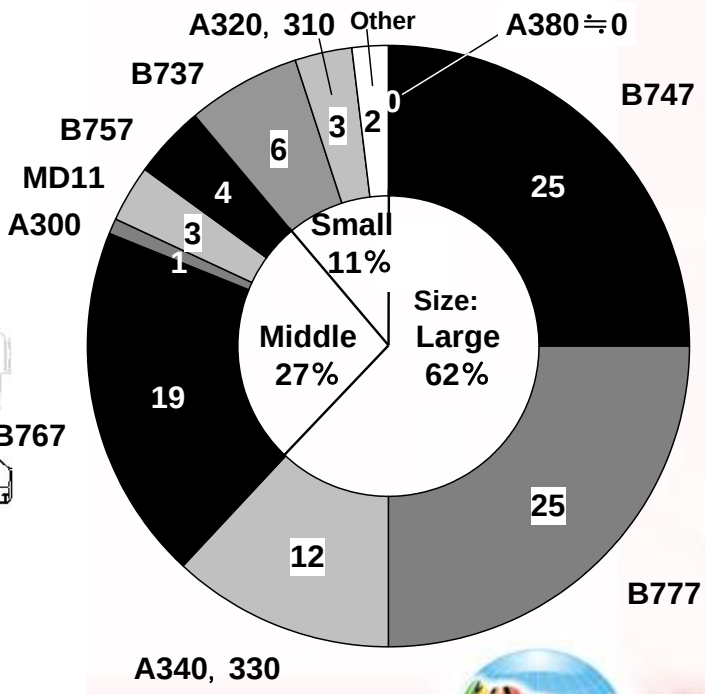
Solar heat-blocking pavement

- Porous asphalt surface measured more than **51° C** whereas solar heat-blocking pavement had a surface temperature of about **46.5° C**.

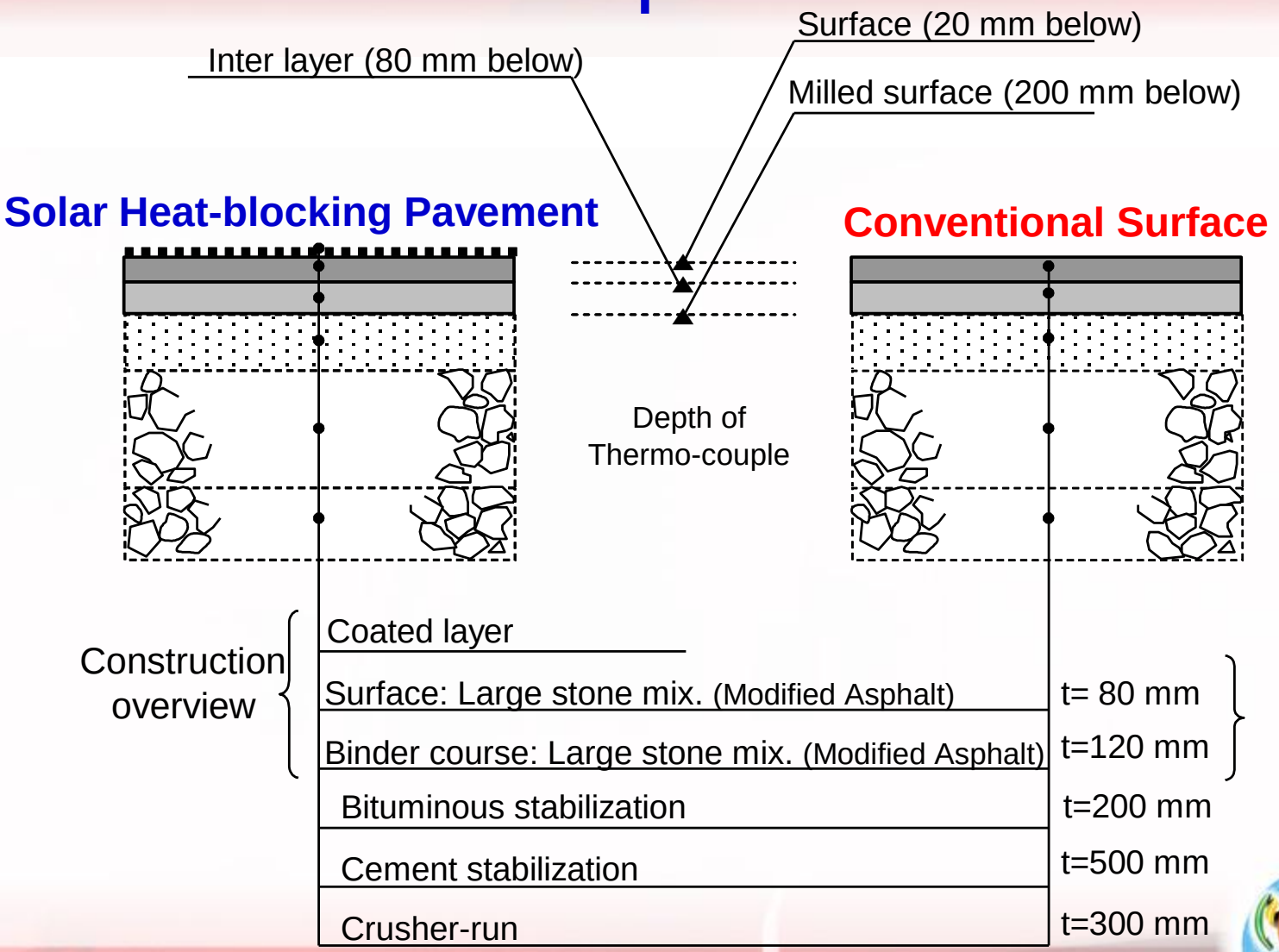
Case studies
- Rutting resistance at airport taxiway -

An International Airport

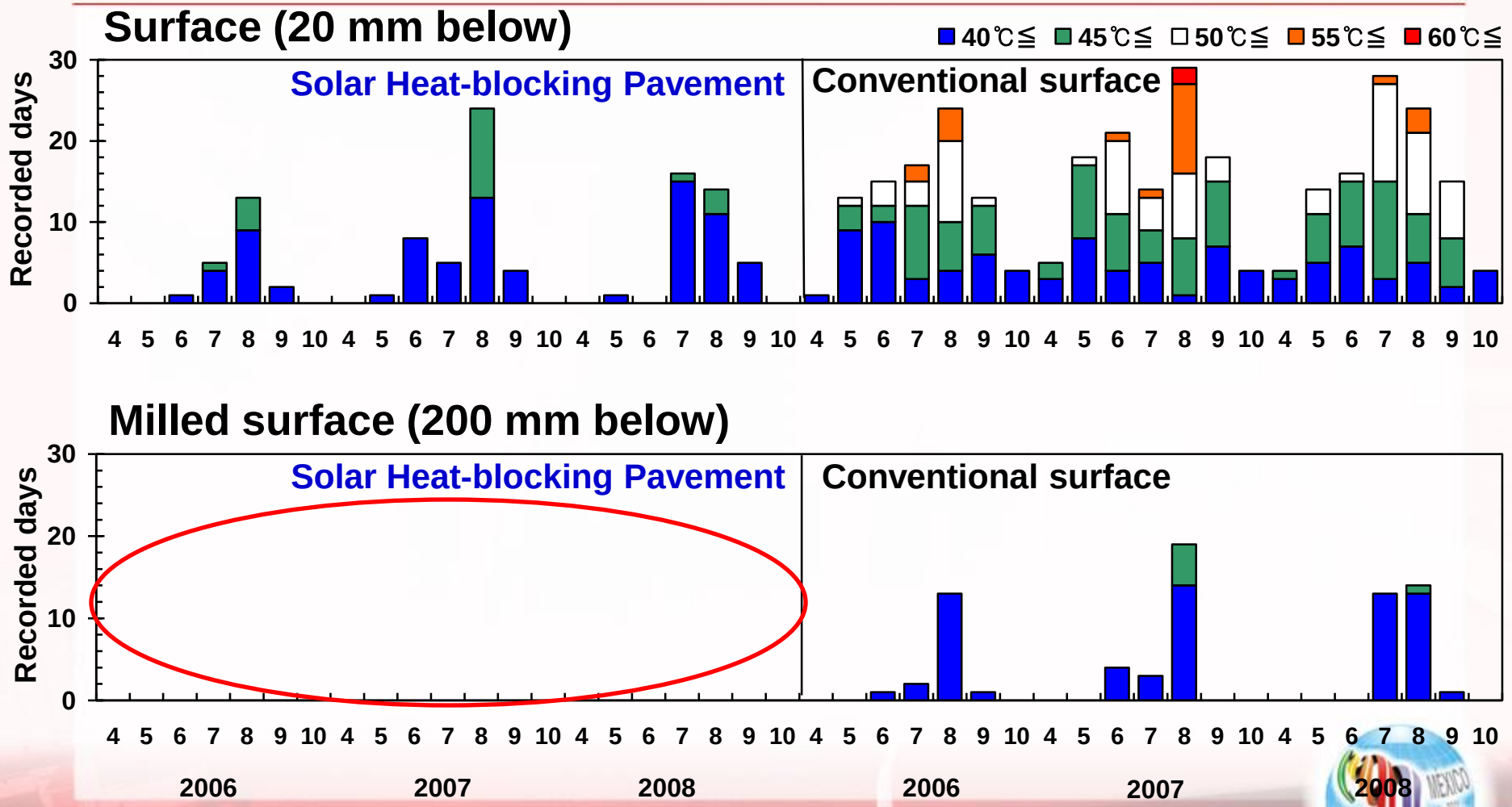




Section of pavements



Days in which 40°C or more was recorded



Temperature below the surface