Current State and Future Prospects of Cool Roof in Japan

Yasushi Kondo, Musashi Inst. of Tech.
Contents

(1) Activities of Cool Roof Committee in AIJ

(2) Private Benefit and Public Benefit of Cool Roof

(3) Cool Roof Promote Project

(4) Conclusions
Contents

(1) Activities of Cool Roof Committee in AIJ

(2) Private Benefit and Public Benefit of Cool Roof

(3) Cool Roof Promote Project

(4) Conclusions
Cool Roof Committee of AIJ

AIJ: Architectural Institute of Japan

Members:
Y. Kondo, Musashi Inst. of Tech.
Y. Ashie, Building Research Inst.
H. Shibaike, Kyoto Inst. of Tech.
H. Takebayashi, Kobe Univ.
H. Namiki, Taisei Co.
K. Narita, Nippon Inst. of Tech.
H. Narimi, Osaka Univ.
M. Nishioka, Osaka City Univ.
S. Hashida, Meiji Univ.
A. Hoyano, Tokyo Inst. of Tech.
Y. Matsuo, Meiji Univ.
I. Misaka, Takenaka Co.
A. Mochida, Tohoku Univ.
M. Moriyama, Kobe Univ.
Main Factors on Heat Island Phenomena

Convection from building surfaces etc. (Increase rate compared to natural surfaces) 47%

Exhaust heat used in building 24%

Exhaust heat used in factories etc. 7%

Heat from DHC plants 1%

Exhaust heat from vehicles 21%

Sensible Heat in Urban Area (Daily Average in Tokyo, Ministry of the Environment)
Half of the surface of Tokyo is covered with artificial materials. Characteristic of building surface materials effects on urban temperature.
The surface temperature of a roof can be decreased by controlling several factors affecting the heat balance of a roof.
The cool roof committee of AIJ discussed latent heat as well as sensible heat.

Therefore the roof planting and water retentive materials are also studied in the committee.
<table>
<thead>
<tr>
<th>Research Group</th>
<th>Research Subject</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashie Lab.</td>
<td>BRI Water Retentive Material</td>
<td></td>
</tr>
<tr>
<td>Mochida Lab.</td>
<td>Tohoku Univ. CFD on Green Area Ratio</td>
<td>S. Yoshida et al. (2003)</td>
</tr>
<tr>
<td>Murakami Lab.</td>
<td>Tokyo Univ. CFD on Roof Planting</td>
<td>S. Yoshida et al. (2002)</td>
</tr>
<tr>
<td>Tokyo Metropolitan Gov. and Japan Testing Center for Construction Materials</td>
<td>Roof Planting and Reflective Paint</td>
<td>T. Fujimoto et al. (2006)</td>
</tr>
</tbody>
</table>
Contents

(1) Activities of Cool Roof Committee in AIJ

(2) Private Benefit and Public Benefit of Cool Roof

(3) Cool Roof Promote Project

(4) Conclusions
Cool roof reduce energy consumption for cooling buildings.  

=> Private Benefit

Cool roof reduce sensible heat flux from roofs to the atmosphere.  

=> Public Benefit

![Diagram showing the comparison between general and cool roofs in terms of solar radiation and cooling load.](image)
Relationship Between Cool Roof and Cooling Load

(Simulation results of summer condition in Tokyo)

![Graphs showing the relationship between cool roof and cooling load.](image)

When the roof is not well insulated, cooling load and/or indoor temperature can be decreased by increasing the rooftop reflectivity.
The total load can only be reduced in hot areas. The effect of high reflective paint on the air-conditioning load depends on the local climate.
How much sensible heat from urban surfaces can be reduced?

(a) Commercial area
   Shinjuku ward
(b) Residential area
   Setagaya ward
(c) Industrial area
   Shinagawa ward

Decrease of Sensible Heat in applying Cool Roof (Ref. 7)

<table>
<thead>
<tr>
<th>Area</th>
<th>Gross building coverage ratio</th>
<th>A Decreased sensible heat [MJ/m^2·day]</th>
<th>B Anthropogenic exhaustion heat (Ref. 11) [MJ/m^2·day]</th>
<th>A/B [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shinjuku ward</td>
<td>36.0</td>
<td>0.95</td>
<td>3.70</td>
<td>25.7</td>
</tr>
<tr>
<td>Setagaya ward</td>
<td>30.0</td>
<td>0.79</td>
<td>1.62</td>
<td>48.7</td>
</tr>
<tr>
<td>Shinagawa ward</td>
<td>29.2</td>
<td>0.77</td>
<td>3.86</td>
<td>19.9</td>
</tr>
</tbody>
</table>
Cool roof can reduce the cooling load of buildings with low insulation.

=> Private Benefit

Cool roof is effective in decreasing urban area temperature in summer.

=> Public Benefit
Contents

(1) Activities of Cool Roof Committee in AIJ

(2) Private Benefit and Public Benefit of Cool Roof

(3) Cool Roof Promote Project

(4) Conclusions
Environment Bureau of Tokyo Metropolitan Government

**Rooftops and Wall Greenery Measures**

Since April 2001 Tokyo Metropolitan Government has required greening rooftops and wall surfaces for new grounds and buildings that have a ground surface of over 1,000m² (250m² for public facilities).

54.5ha of rooftops have been greened as of January 1, 2005.

http://www2.kankyo.metro.tokyo.jp/kouhou/env/eng/index.html
Cool Roof Promote Project started in 2005

http://www2.kankyo.metro.tokyo.jp/heat/coolroof/coolroofpress.pdf

Committee to Promote Cool Roof  http://www.coolroof.jp/

Members:

- Environment Bureau of Tokyo Metropolitan Government
- Several Tokyo wards: Chiyoda ward, minato ward, shinjyuku ward etc.
- Japan Paint Manufactures Association
- Center for environmental Information Science
- NPO Roof development research center

The building owners who apply rooftop greening or high reflective paint can get a grant from Ministry of the Environment, if they meet the requirements.
Many high reflective paint products are distributed in the Japan market.

However there is no authorized standard for performance of high reflective paints in Japan.

A standard or qualification system should be considered in Japan.
Reflectance Spectra of Various Reflective Paint Products

(Ref. 6)

The performance of 21 reflective paints was examined.
Comparison of Solar Reflectance in Various Products
Ageing of Reflective Paints by Exposure Testing

16 white paints  14 gray paints  14 black paints

Results of Ageing Test on Reflective Performance

White (Product No.13)  Black (Product No.13)
### Example (Product No.13)

<table>
<thead>
<tr>
<th></th>
<th>Solar Reflectance [%]</th>
<th>Visible Ray Reflectance [%]</th>
<th>Infrared Ray Reflectance [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not exposed</td>
<td>Not exposed</td>
<td>Not exposed</td>
</tr>
<tr>
<td></td>
<td>571 days later</td>
<td>571 days later</td>
<td>571 days later</td>
</tr>
<tr>
<td>White</td>
<td>80.8</td>
<td>85.2</td>
<td>82.1</td>
</tr>
<tr>
<td></td>
<td>54.8</td>
<td>50.4</td>
<td>61.4</td>
</tr>
<tr>
<td>Black</td>
<td>40.4</td>
<td>5.8</td>
<td>71.2</td>
</tr>
<tr>
<td></td>
<td>30.7</td>
<td>6.9</td>
<td>51.5</td>
</tr>
</tbody>
</table>

When high reflective paint is applied, the ageing of performance should be considered. The recovery method of performance should be studied.
(4) Conclusions

[1] The research studies on cool roof in Japan are shown.

[2] Private benefit and public benefit of cool roof are shown.

[3] An example of cool roof promote project is introduced. Some problems to promote the application of cool roof are discussed.

The designers and owners of building should recognize the private benefit of cool roof properly and apply it.

The policy maker should recognize the public benefit of cool roof properly and promote it.
High Reflective Paints


3) http://www.coolroof.jp/faq/index.html


References (Referred papers in this presentation are numbered.)


Roof Greening


References (Referred papers in this presentation are numbered.)


References (Referred papers in this presentation are numbered.)


Others
