The Runoff Reduction on Green Roof
Influence of Different Characteristics

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Background

Runoff Simulation considering the Japanese rainfall patterns (S. Kikuchi et. al, 2009)

**Japanese rainfall patterns**
- Torrential rain
- Typhoon
- Baiu, Japanese rainy season

In the early stage of localization torrential rain
the reduction effect of rainfall outflow
Background

Runoff Simulation using the runoff coefficient of the green roof drainage layers (S. Kikuchi et al., 2009)

The runoff coefficients
- the traditional green roof systems; 0.80
- the green roof drainage layers; 0.63

For three scenarios
- showed in 3D on the GIS
- Styrofoam scenario achieved the smallest to describe the urban rainfall process and vertically linked sequence of events
Objectives

Storm water runoff simulations are done by using the Japanese green roof systems with Styrofoam water retention layer.

The runoff volume was compared the thickness of the water retention layer and soil water conditions.
Contents

Outflow experiment with Japanese green roof systems

Calculation of runoff coefficient and runoff delay time

Comparison of the storm water volume between the thickness of water retention layer and soil water conditions

Conclusions and future
Outflow experiment with Japanese green roof system

Curing period: 18th Jan. 2010 – 5th Mar. 2010


Design rainfall intensity: 75mm/hr

Rainfall duration time: 1 hour
(6:00 pm – 7:00 pm)

Recording interval: 1/600 second

Used equipment:
Rainfall simulator, DIK-6000S (Daiki Rika Kogyo Co., Ltd.)

A non-wetted, electrode-type electromagnetic flow sensor, FD-SS2A (Keyence Corporation)

Touch Screen Paperless Recorder TR-V500 (Keyence Corporation)
Samples

Among various Styrofoam water retention layer developed by green roof systems manufactures, three kinds of layers of different thickness and different uneven surface structure on front and rear surface were selected.
Structure of Japanese green roof system

**Kentucky Blue Grass, Midnight II (Poa pratensis)**
- Compact size of turf-grass species
- Non edaphic grass
- Resistant characters: low temperature, hot tolerance, and drought

**Artificial lightweight soil**
- Free of organic substances
- Free of fertilizers
- Material: coal ash (from heat power plants)

**Pervious filter**
- nonwoven fabric
Rainfall interval

Watering of the thirsty green roof panels

Prepare for each outflow experiment by not irrigate
Experimental results: dry condition
Experimental results: saturated condition
# Runoff coefficient and runoff delay time

<table>
<thead>
<tr>
<th>T (mm)</th>
<th>Dry condition</th>
<th>Saturated condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Runoff delay time (min)</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Arrival time of peak discharge (L/min)</td>
<td>43</td>
<td>60</td>
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<td>Termination time of peak discharge (L/min)</td>
<td>74</td>
<td>73</td>
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<tr>
<td>Peak discharge (L/min)</td>
<td>0.117</td>
<td>0.094</td>
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<tr>
<td>Cumulative volume (L)</td>
<td>6.342</td>
<td>4.478</td>
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<tr>
<td>Runoff coefficient</td>
<td>0.39</td>
<td>0.30</td>
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</table>
Case study area: Chiyoda, Tokyo
<table>
<thead>
<tr>
<th>name</th>
<th>Flood Frequency</th>
<th>Area(m²)</th>
<th>Elevation Average (m)</th>
<th>Population</th>
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<td>81,697</td>
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</table>
Setup condition

Rainfall condition: 4th July 2000

Roof condition:
The conventional roof,
Green roof system under the dry condition,
Green roof system under the saturated condition

Simulation:
All buildings with the conventional roof,
All buildings with the green roof systems under the dry condition,
All buildings with the green roof systems under the saturated condition,
All buildings with the green roof systems (½ dry condition, ½ saturated condition)
Method of calculation

\[ Q = C \times I \times A \]

\( Q \) : Countermeasure of Runoff volume (m\(^3\))

\( C \) : Runoff Coefficient

- 0.90 for the conventional roof, 0.39 for the green roof systems under dry condition and 0.48 for the green roof under saturated condition.

\( I \) : Rainfall intensity, 4 July 2000

\( A \) : Countermeasure of Area (m\(^2\))

As the runoff delay time, 20 minutes of green roof systems under dry condition and 75 minute for the green roof under saturated condition.
Conventional roof, green roof under dry and saturated condition
conventional roof
6:00pm – 8:00pm
green roof under the dry condition
6:00pm – 8:00pm
green roof under the saturated condition 6:00pm – 8:00pm
The number of half, under the dry and saturated condition
Half
6:00pm – 8:00pm
conclusions
In the future...
Acknowledgments

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References


Thank you very much for your attention!!
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