Field Observations of the Air Flow and Heat Budget of East-west Urban Canyon. - I . Air Flow Characteristics.

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Urban area can be considered as an assembly of various shapes and sizes of urban canyon. The climate of urban canyons is primarily controlled by micrometeorological effects of canyon geometry, though it is also affected the mesoscale phenomenon in urban boundary layer. The typical flow regimes in an urban canyon - for example the existence of a vortex cell associated with ambient winds perpendicular to the street, have been referred in a number of studies. But only few field observations have so far been made in real urban canyons, especially respecting a wider main street.

This study presents an analysis of the air flow characteristics for east-west urban canyon (located in Hiroshima, Japan: width(**W**)=40.05m), based on three dimensional wind components data which are measured with four ultra-sonic anemometers mounted along pedestrian bridge.

Fig.1 shows the location of measuring site and the condition of surroundings. (Regarding the detail of instrument arrangement, see Fig.1 in Part II.) The 10-minute mean of each component at point N1, N2, S2 and S1 (originally sampled in frequency of 10Hz) are summarized in Fig.2 as well as wind speed and direction of above canopy layer. It is clear that the strong circulation flow are derived from southerly see-breeze during daytime and counter-circulation flow corresponding to land-breeze are also appeared in the early morning. As for the parallel component to the street, its direction changes due to the deflection of upper wind direction from right angle to the street. Besides, distribution of instantaneous wind direction and its correlation to instantaneous air temperature variation are also analyzed.

In addition to those stationary observations, the simultaneous moving observation were carried out at points which have different street geometry around the bridge.

⁽¹⁾ DePaul F. T. and Sheih C. M. (1986): Atmos. Environ., 20, 455-459.

⁽²⁾ Oke T. R. (1988): Energy Bldng, 11, 103-113.

⁽³⁾ Hunter L. J., Watson I. D. and Johnson G. T. (1990/91): Energy Bldng, 15-16, 315-324.

⁽⁴⁾ Johnson G. T., Hunter L. J. and Arnifield A. J. (1990/91): Energy Bldng, 15-16, 325-332.

⁽⁵⁾ Hunter L. J., Watson I. D. and Johnson G. T. (1992): Atmos. Environ., 26B, 425-432.

⁽⁶⁾ Arnifield A. J. and Mills G. M. (1994): Int. J. Climatol., 14, 119-134.

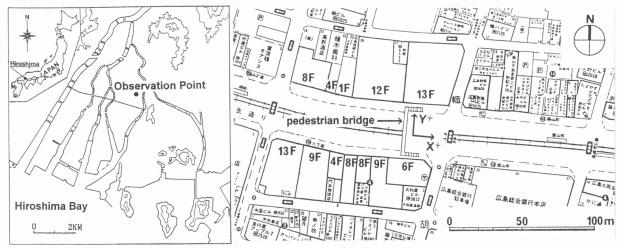


Fig.1 Location of measuring site

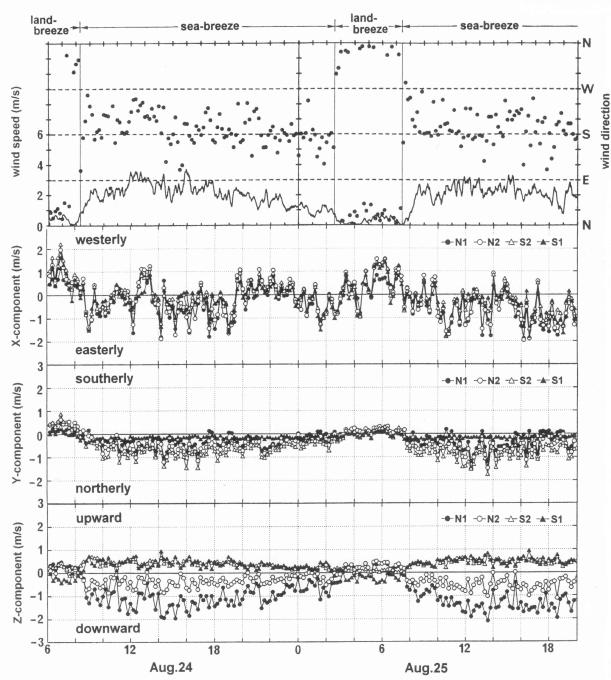


Fig.2 Time variations of each component of air flow within urban canyon

Field Observations of the Air Flow and Heat Budget of East-west Urban Canyon. - II. Heat Budget.

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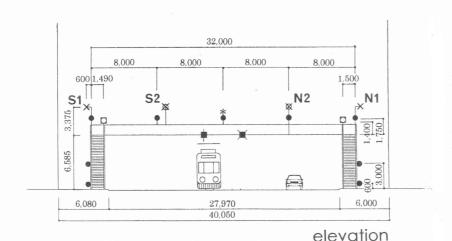
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Continued from the preceding paper (Part I), an analysis of heat budget within the urban canyon were described here. Another purpose of this study is to clarify how traffic exhaust heat contributes to the thermal environment in street canyon.

Fig.1 is a schema of instrument arrangement around the pedestrian bridge. Each data, except for the ultrasonic-anemometer, was collected at intervals of 10-seconds. Besides, 10 scenes of thermal image which contains the road surface and



building wall around were taken from the bridge every 1-hour. And to monitor a traffic and sun shadow, VTRcameras were equipped both side of the bridge.

The street in question consists of a

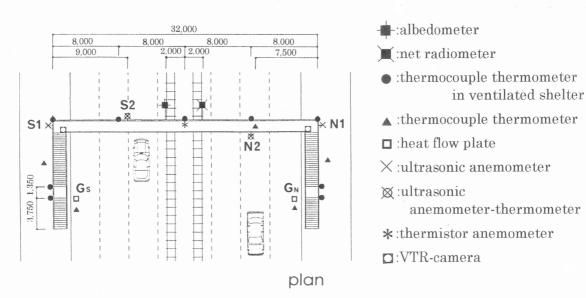


Fig. 1 Outline of instrument arrangement

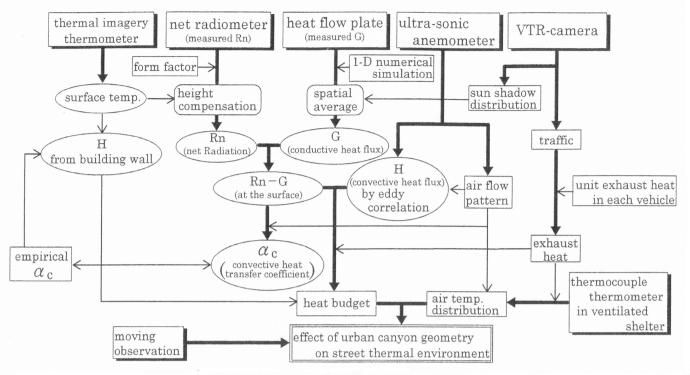


Fig.2 Flow chart of this study

six-lane roadway, tracks of streetcar and sidewalks in both side. Because of a limitation about the observation site, some instruments were not necessarily set up at intended location. For example, net radiation (**Rn**) was measured at the height of bridge (**H**=6.7m), and conductive heat flux into ground (**G**) was measured at restricted only two points near the sidewalk.

In order to compare the value of (Rn-G) with the sensible heat flux (H) by eddy correlation method, some treatments for the original value of Rn and G were attempted (see Fig.2). The error in Rn caused by measurement at high place is compensated with the surface temperature and the form factor of both-side building under the measuring height. Spatial average of G is obtained by means of a one-dimensional numerical simulation using a sun shadow distribution data.

As for a exhaust heat, it was evaluated from a traffic number and unit exhaust heat in each kind of vehicle. A convective heat transfer coefficient at road surface was calculated from sensible heat flux and surface-air temperature difference and it was compared with some empirical formula.

- (1) Nunez M. and Oke T. R. (1977): J. Appl. Meteor., 16, 11-19.
- (2) Nakamura Y. and Oke T. R. (1988): Atmos. Environ., 16, 259-266.
- (3) Yoshida A., Tominaga K. and Watatani S. (1990/91): Energy Bldng, 15-16, 417-423.
- (4) Mills G. M. (1993): Atmos. Environ., 27B, 157-170.
- (5) Mills G. M. and Arnifield A. J. (1993): Atmos. Environ., 27B, 171-181.
- (6) Arnifield A. J. and Mills G. M. (1994): Int. J. Climatol., 14, 239-261.