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# On some Climatological Problems of the Wall and Window Facing West or East—A Preliminary Report on a Building of Ochanomizu University

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## I. Introduction

1. A Japanese tradition tells us that the house should never have windows facing west to avoid summer scorching.

2. Our faculty's building, newly constructed on June 1972, has paid considerable attention to sunshine. For instance, the roof is covered by "ventilation block" which has four legs and conserves about 4.5 cm air layer between the block and roof, secondary, undersurface of the roof is covered by 2 cm-thick foam styrol, and thirdly, the west or east facing windows were originally designed to be installed only at the both ends of the south and north corridors running east-west. In the final plan, however, most of these terminal parts of the corridors were included in the nearby rooms to widen them and then the scorching problem in summer took place.

3. The west or east side wall is 15 cm-thick iron concrete with dark coloured brick on it. This wall is the problem. In the late afternoon in summer, it gives us a feeling of Russian "Pechika" radiating longwave heat, and the waterway on this wall pours "hot water" for several seconds when we open its cock.

4. The author supposes that Tokyo or the urbanization of Japan, would produce countless complaints caused by now silent but innumerable nuisance, if the urban or building climatologist and architect do nothing. They would also lead people to unnecessary expensive investiment or to more air pollution, etc.

These four points lead the author to this preliminary observation.

## II. Building design and use state

1. Astronomical direction: Building's front faces S12°E.

2. Use state in the last summer: The south part of the first floor was cooled by three air conditioners for the faculty business. 2-6th floors were almost closed. 7th floor was open except Sundays,

but Rooms 702 and 717 were normally open from Monday to Thursday and closed from Friday to Sunday. Room 701 has a small air conditioner of only 1250 kcal/h for its 45 $m^2$ area and so the windows were mostly closed. 8th floor was opened occasionally. On 25th Aug. a strong air conditioner of 2500 kcal/h was installed in Room 702 with only 17 $m^2$, so it could be very cool thereafter.

## III. Climatological observation

Observation of wall temperature was begun on July 19th, 1972 by IT-3 infrared thermometer, as the "Pechika-like" feeling stimulated the author to detect it. He recognized, for the first time, that west wall inside temperatures were 29°C at 11 h, 30°C at 14 h, 32°C at 15 h, 35°C at 18 h and 36°C at 19–20 h. He made up his mind to observe building climate and prepared various apparatus for it from July 20 to Aug. 2, which are shown on Plate I.

The self-recorders, from which Table II and Fig. 3 were compiled, were started on Aug. 3rd and continued until Sept. 7th. Horizontal and vertical observations of wall-, ceiling- and floor temperature by IT-3 infrared thermometer were carried on Aug. 8th partially and Aug. 31st completely.

These preparation and observation were indebt heavily to Mr. Nobuyuki OTA and partially to Mrs. Hisako KAIYAMA. The author wishes to express his heartful thanks for their kindness and endeavour.

## IV. The main results

1. The vertical temperature distribution of ceiling, floor, wall and glass wall by IT-3 infrared thermometer.

Fig. 1 shows the results clearly, although the physical possibility to draw the isotherms of such temperature, unlike air temperature which fills space continuously, is not strictly analyzed yet. The main features of Fig. 1 are as follows:

1) The lower floors and the core of the building are cooler than upstairs and the sides. The difference of the former reached at 5°C on Aug. 31st.

2) The north corridors are cooler than the south ones on the same floor. It suggests that the cool area exists somewhere around the northern part of the building. This is clearer on Fig. 2.

3) Even at 16 h observation, the east wall still shows 33.8°C, and air temperature gradient near the wall was steep yet.

4) The western end of the floor becomes very hot even if the floor receives no direct insolation, resulting in the going up of ceiling temperature.

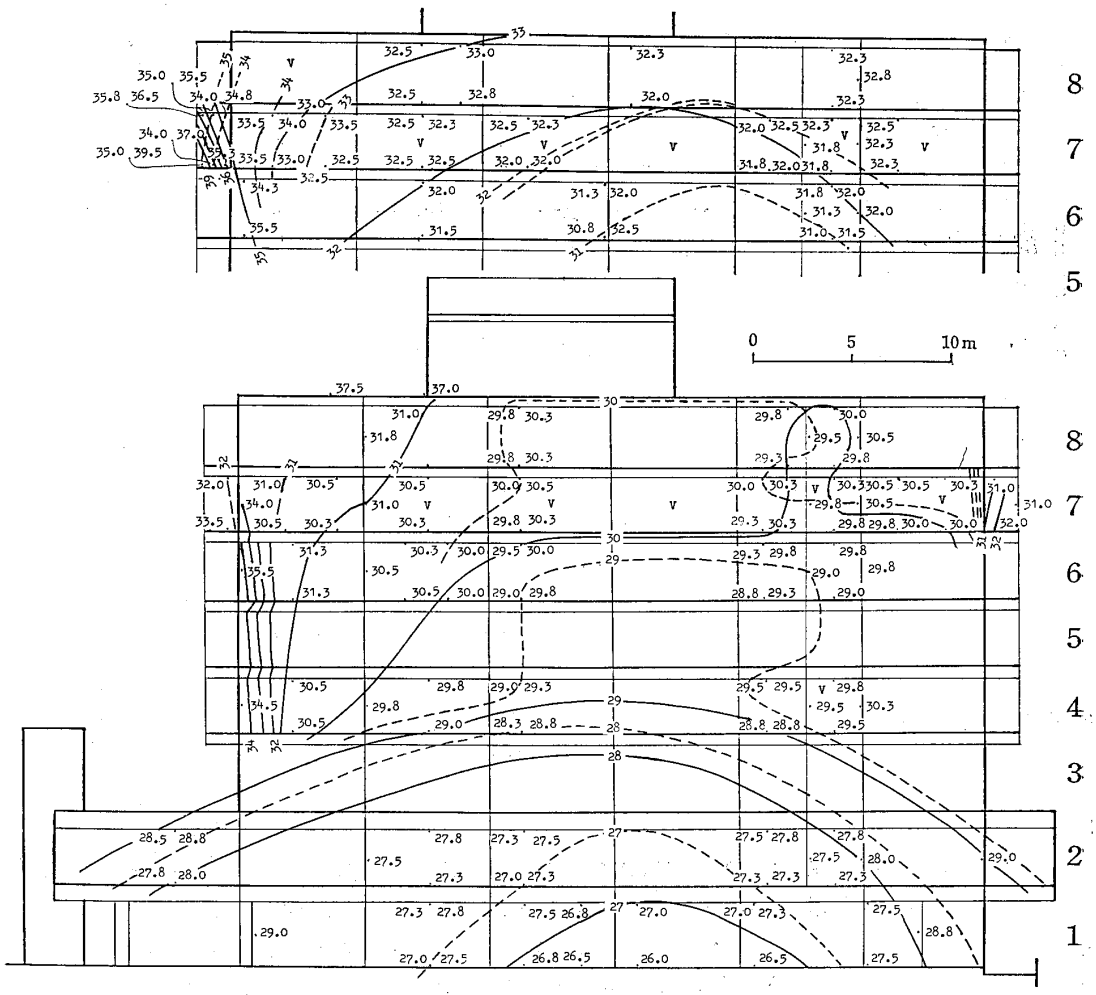



Fig. 1. Vertical temperature distribution of ceiling, floor, wall and glass wall, observed on Aug. 8th (upper) and 31st (lower).

Solid line: Isotherms mainly along the south corridor, which are drawn by values shown on a right side of observational points.

Dashed line: Isotherms mainly along the north corridor, which are drawn by values shown on a left side of observational points.

V: Opened and ventilated room.

5) The effects of the ventilation block and foam styrol are enormous, as shown by a big difference in temperature between roof and ceiling of 8th floor comparing with the case of the east and west wall temperatures.

2. Horizontal temperature distribution of wall, glass wall, and floor by IT-3 infrared thermometer.

Fig. 2 shows them clearly. (Fl.) means floor temperature. Main features are as follows:

6) The cool area exists at the northern part of east step room, as touched in 2) already.

7) Other features are mentioned already in 3) and 4).

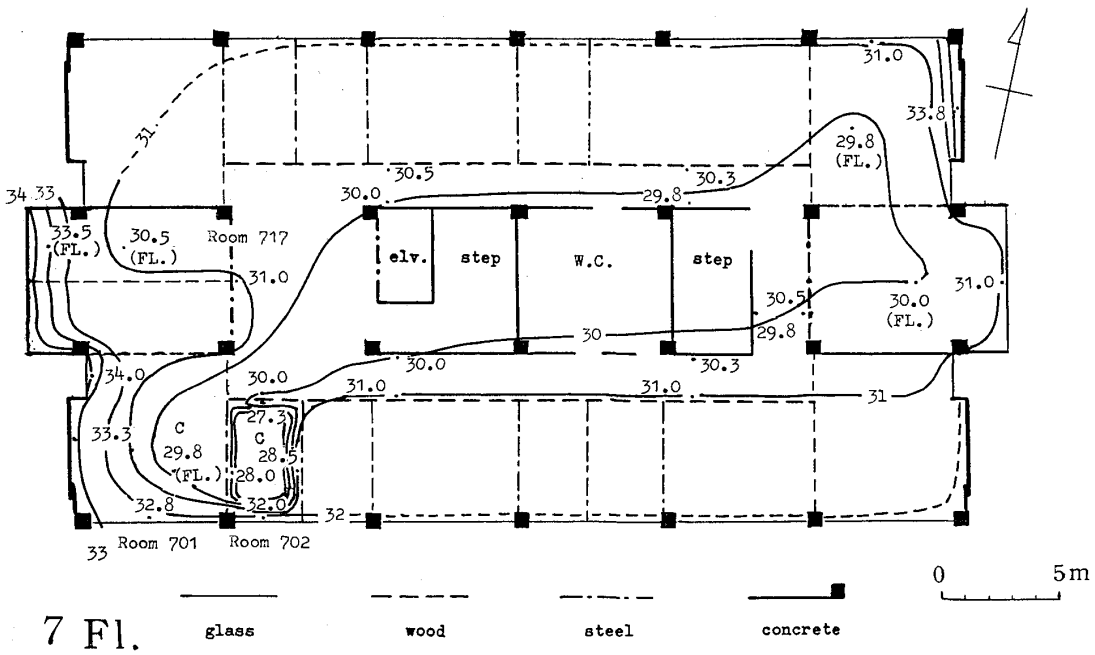



Fig. 2. An example of the horizontal temperature distribution of wall, glass wall and partially floor (Fl.), observed by an infrared thermometer on Aug. 31st, 1972. Building plan and its materials are briefly shown. C: cooled by air conditioner.

3. Delay of the maximum inside temperature of the east wall.

Table 1 is the data obtained by Mrs. Kaiyama. This table tells us an unexpected delay of the maximum temperature occurrence around 16 h or 16 h 30 m with an unexpectedly high temperature of 33.8°C. These suggest that an east side room is not always better than a west side room because its maximum temperature may take place in late business hour with such an unexpected high temperature.

Table 1. Hourly march of wall temperature inside of east wall by the infrared thermometer IT-3. (Aug. 31st, 1972)

| Time | Wall temp. °C | Air temp. °C |
|---|---|---|
| 10 : 45 | 31. 0 | 30. 0 |
| 11 : 00 | 31. 5 | 29. 8 |
| 11 : 30 | 32. 1 | 30. 3 |
| 12 : 00 | 32. 5 | 30. 5 |
| 12 : 30 | 33. 0 | 30. 5 |
| 13 : 00 | 33. 1 | 30. 4 |
| 13 : 30 | 33. 2 | 30. 5 |
| 14 : 10 | 33. 5 | 30. 8 |
| 14 : 30 | 33. 5 | 31. 0 |
| 15 : 00 | 33. 7 | 31. 0 |
| 15 : 35 | 33. 8 | 31. 0 |
| 16 : 00 | 33. 8 | 31. 1 |
| 16 : 30 | 33. 8 | 30. 8 |

4. Delay of the maximum temperature of the west wall.

These compiled data are (1) and (2) in Table 2, especially the column of mean. Maximum occurs at 19 h 12 m and not 12 hours later than that of east wall. Minimum occurs at 8 h 36 m. The air temperature of narrow space between the wall and a furniture is almost closely regulated by wall temperature for both value and delay.

Table 2. Max. & Min. Temperatures on every Sunday in summer 1972 by several points and heights on 7th floor.

| | Sorts of observation and (direction), (instruments) | | 1972 August | | | | Sept. | Mean |
|---|---|---|---|---|---|---|---|---|
| | | | 6 | 13 | 20 | 27 | 3 | |
| Max. temp. on Sundays | (1) Inside of west wall (Resist. therm. No. 3) | temp. °C | 39.8 | 36.7 | 35.5 | 34.0 | 34.6 | 36.12 |
| | | time | 20:00 | 19:30 | 18:30 | 19:15 | 18:45 | 19:12 |
| | (2) Narrow space betw. wall and furniture (do. No. 5) | temp. °C | 37.2 | 33.4 | 33.8 | 30.4 | 32.0 | 33.36 |
| | | time | 20:00 | 20:30 | 18:00 | 18:15 | 18:45 | 19:06 |
| | (3) Inside of west glass wall (do. No. 4) | temp. °C | >50 | — | — | 68.0 | 63.1 | — |
| | | time | 16:50 | — | — | 16:05 | 15:25 | — |
| | (4) 1.3 m air in Room 701 (S & W) (Bimetal) | temp. °C | 35.0 | 33.2 | 33.5 | 29.5 | 31.9 | 32.62 |
| | | time | 17:00 | 16:30 | 16:00 | 15:45 | 14:00 | 15:51 |
| | (5) 0.8 m air in Room 702 (S) (Bimetal) | temp. °C | 35.0 | 34.0 | 34.5 | 29.9 | 31.8 | 33.04 |
| | | time | 13:00 | 13:00 | 13:00 | 13:00 | 13:30 | 13:06 |
| | (6) 2.0 m air in Room 717 (W) (Bimetal) | temp. °C | 38.8 | 41.0 | 38.3 | 35.3 | 35.5 | 37.78 |
| | | time | 16:15 | 18:00 | 15:45 | 17:40 | 16:15 | 16:47 |
| | (7) Outside free air (Mercury self-recorder) | temp. C° | — | — | 33.2 | 28.5 | 27.2 | — |
| | | time | — | — | 16:30 | 11:00 | 14:00 | — |
| Min. temp. on Sundays | (1) Inside of west wall (Resist. therm. No. 3) | temp. °C | 32.1 | 29.5 | 29.5 | 25.0 | 28.3 | 28.88 |
| | | time | 9:30 | 8:45 | 7:30 | 7:45 | 9:30 | 8:36 |
| | (2) Narrow space betw. wall and furniture (do. No. 5) | temp. °C | 32.3 | 29.0 | 28.8 | 25.0 | 28.5 | 28.72 |
| | | time | 7:45 | 7:00 | 6:00 | 5:45 | 9:30 | 7:12 |
| | (3) Inside of west glass wall (do. No. 4) | temp. °C | 30.0 | — | — | 23.7 | 26.5 | — |
| | | time | 3:45 | — | — | 5:00 | 5:30 | — |
| | (4) 1.3 m air in Room 701 (S & W) (Bimetal) | temp. °C | 31.5 | 29.4 | 29.0 | 25.4 | 29.0 | 28.86 |
| | | time | 6:00 | 5:30 | 5:30 | 6:00 | 2:00 | 5:00 |
| | (5) 0.8 m air in Room 702 (S) (Bimetal) | temp. °C | 32.0 | 31.0 | 31.1 | 25.8 | 28.8 | 29.74 |
| | | time | 5:45 | 5:30 | 5:15 | 5:30 | (7:00) | 5:48 |
| | (6) 2.0 m air in Room 717 (W) (Bimetal) | temp. °C | 32.5 | 32.7 | 33.0 | 27.0 | 29.9 | 31.02 |
| | | time | 7:00 | 5:30 | 5:40 | 6:00 | 7:00 | 6:14 |
| | (7) Outside free air (Mercury self-recorder) | temp. °C | — | — | 26.6 | 21.0 | 22.2 | — |
| | | time | — | — | {6:00 3:00 | 5:00 | 5:00 | — |

5. Temperature variation of the west glass wall.

The glass wall is illustrated on the right side of Plate I-G. This is tightened seven columnar glass tubes with vacancy inside. This diurnal temperature range is very large from 68°C to 23.7°C for instance. Delay is very little compared to the wall. This means that air temperature near glass wall rises conspicuously in the middle afternoon and falls abruptly after the sunset.

6. Three types of diurnal temperature variation according to the room direction. These data are shown in Table 2-(4), (5), (6) and Fig. 3. The former tells us that morning minimum of three rooms

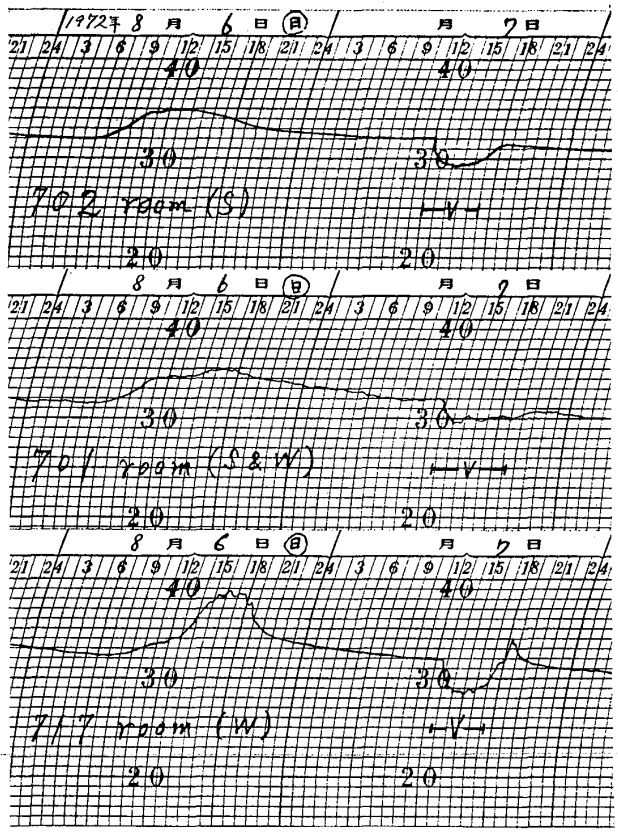
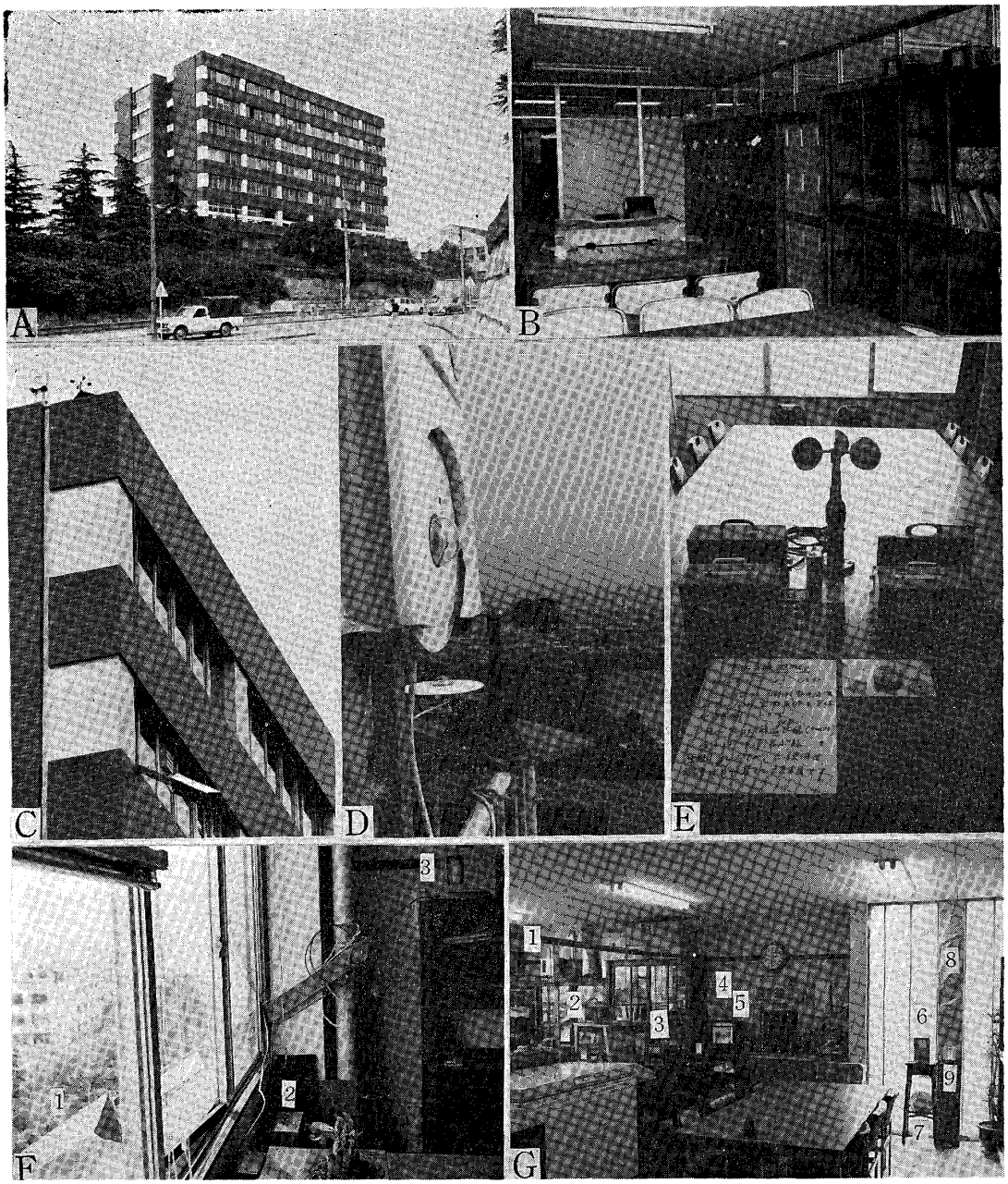



Fig. 3. Three types of diurnal temperature variation according to the room direction. (V: ventilated)

occur almost at same hour, but maximum are quite different; south facing Room 702 or (5) has its maximum at 13 h 06 m, west facing Room 717 or (4) has it at 16 h 47 m, and south and west facing Room 701 or (4) at 15 h 51 m. Fig. 3 illustrates these relations obviously. Room 701 shows tripple rises at about 13 h and 17 h which coincide with Room 702 and 717 respectively, and at 20–22 h which coincides with west wall temperature maximum (1).

I should like to dedicate this urban-climatological paper to Dr. Shinzo KIUCHI for the celebration of his retirement from Tokyo University.




A: The University Building for the Faculty of Letter and Education.
B: Room 717 (Student Room) with west facing windows. Two self-recording thermometers are on the right shelved cabinet.
C: Relative position of west facing solarimeter and anemometer on the roof and a shelter for the self-recording thermometer of outside air, which was set up at a window of Room 701.
D: West facing solarimeter, anemometer and horizontal solarimeter.
E: Room 702 with south facing windows. Instruments are, from left front clockwisely, self-recording thermometer, anemometer and its cup, barograph and hygrometer.
F: Several instruments and devices in the author's room 701. 1. shelter, 2. self-recorder of anemometer, 3. self-recording thermometer of outside air.
G: 1. Same as F-3, 2. self-recording thermometer of this room air, 3. Barnes IT-3 infrared thermometer, 4. resistance thermometer on the wall, half covered by empty case of foam styrol. Thermometer for narrow space temperature between wall and furniture is 50 cm left from 4, but can not be seen, 5. 12 points recorder (Iio Denki E678), 6. self-recorder of solarimeter 7 facing west glass wall, 8. aluminium foil covering one columnar tube of glass wall. 9. Same as G4 but for the reflection effect of aluminium foil.