creation of building shadow by decreasing building distance in Sendai. Fig. 5 gives the distributions of surface temperatures of ground and building in Guangzhou and Sendai. As shown in Fig. 5, due to the obstruction of the sunshine by buildings, a significant building shadow is observed behind buildings in Sendai.

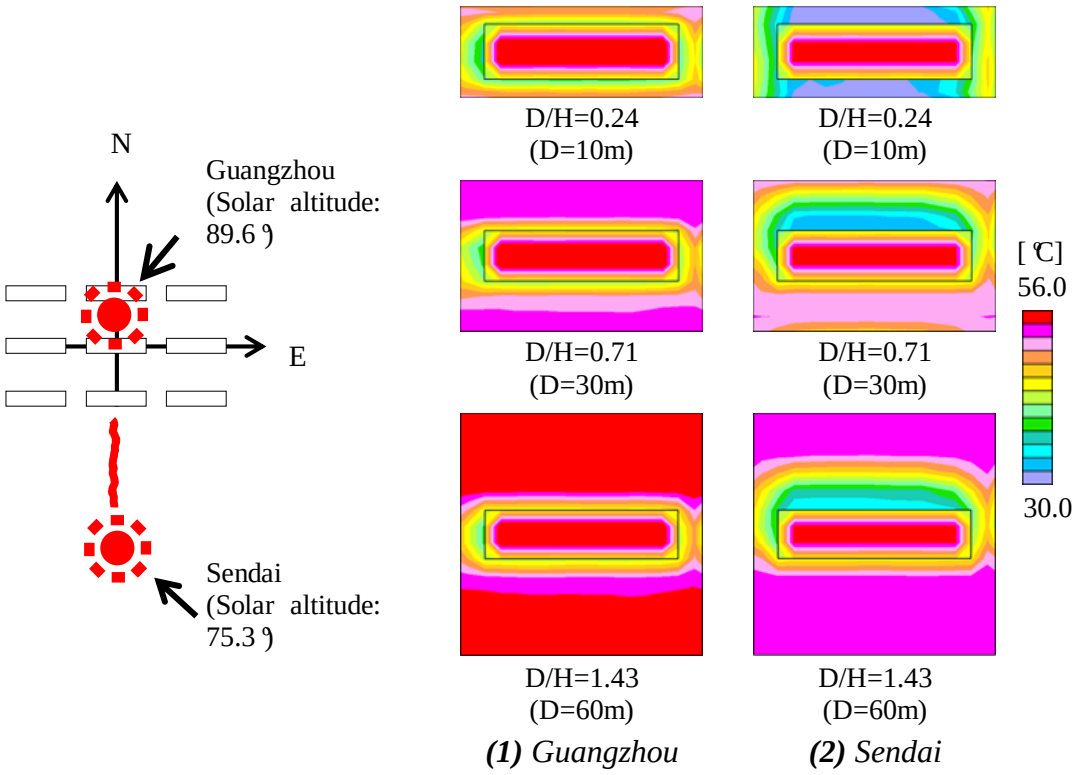


Fig. 5 *Distribution of surface temperature of the vertical surfaces*

According to Figs. 4 (3) ~ (6), the shortwave radiation heat gains on the vertical surfaces are apparently less than that on the horizontal surfaces. The heat gains by shortwave radiation per square meter on the east surfaces reach the peak values in the morning and those on the west surfaces reach peak values in the afternoon in the two cities. The reason is that the surface which is under the direct sunshine receives the larger shortwave radiation.

When focusing on Figs. 4 (5) and (6), with a decrease in building distance, the heat gains on the north and south surfaces decrease. The heat gain on the south surfaces in Sendai is apparently greater than that in Guangzhou (Fig. 4 (6)). This is due to the lower solar altitude leading more direct sunshine on the south surface during the whole day.

Heat Gain By Longwave Radiation

As shown in Figs. 6 (1) and (2), the longwave radiation heat gains on the horizontal surfaces (roof and road) have negative values during the daytime. This means that these surfaces emit heat in terms of the longwave radiation. The horizontal surfaces being highly exposed to the sunshine due to the high solar altitude strongly absorb the

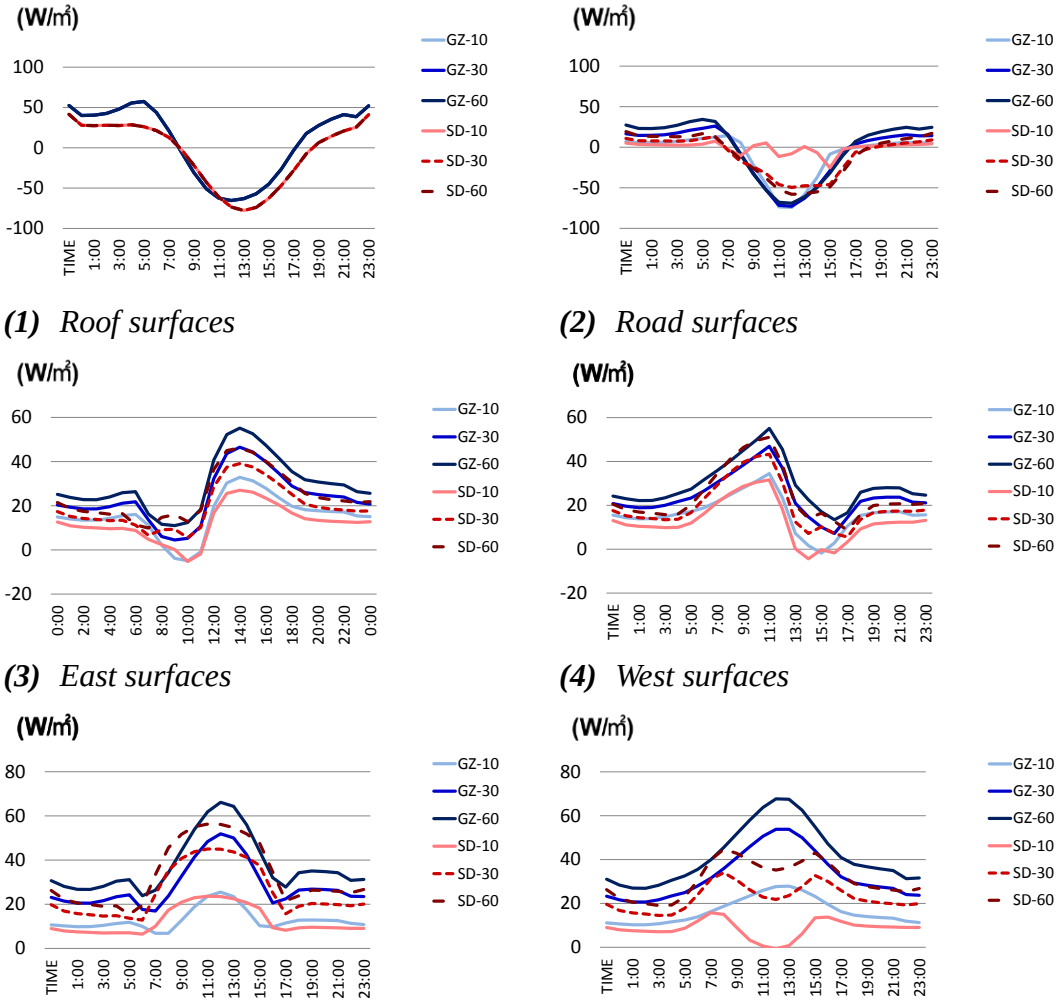


Fig. 6. *Heat gain by Longwave radiation*

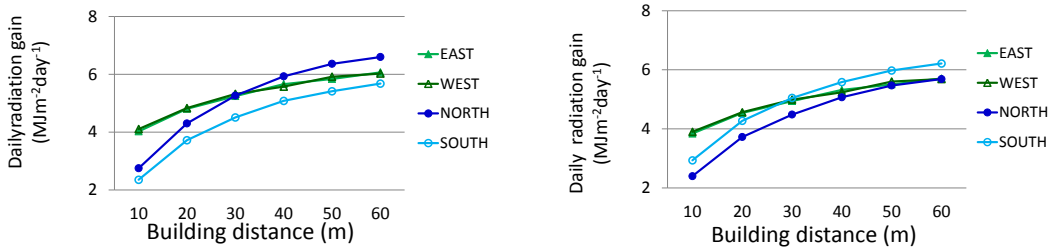
shortwave radiation as shown in Fig. 4 and their surface temperatures increase rapidly, and therefore, more longwave radiations are emitted from these surfaces.

As shown in Fig. 6 (2), the longwave radiation emission of the road surface in Sendai is smaller than those in Guangzhou. With an increase in building distance, the longwave radiation emission becomes more. In SD-10, the shortwave radiation is difficult to reach the area of building shadow (shown in Fig. 5) and therefore the increase of the surface temperature under building shadow is smaller compared with that in the exposed area. This leads the smaller longwave radiation emission from the road surface.

Figs. 6 (3) ~ (6) show that the values of the heat gain by the longwave radiation on the vertical surfaces are almost plus in both Guangzhou and Sendai. Due to less exposure level of the vertical surfaces compared with that of the horizontal surfaces, the shortwave radiation heat gain on the vertical surfaces is less than that on the horizontal surfaces, and this will lead to a relatively lower surface temperature on the vertical surfaces. This indicates that the vertical surfaces will absorb the longwave radiation. Under strong solar radiation, with the surface temperature growing up, the

east and west surfaces even begin to emit longwave radiation.

Daily Net Radiation Heat Gain



***(1)** Guangzhou* ***(2)** Sendai*

***Fig. 7.** Daily net radiation gain on the vertical surfaces in Guangzhou and Sendai*

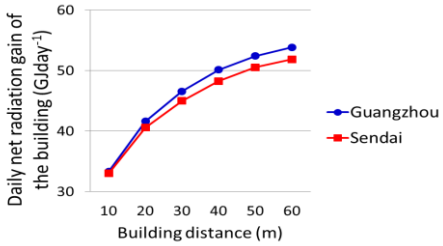


***Fig. 8** Total daily net radiation heat gain of one building in different building arrangements*

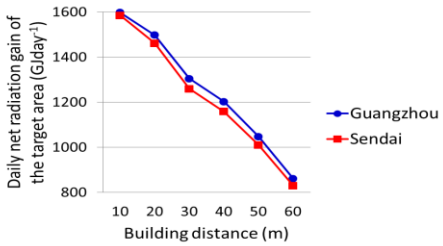


***Fig. 9** Daily total net radiation gain of all buildings in the target area in different building arrangements*

Fig. 7 shows the daily net radiation heat gains on the vertical surfaces of one building in different building arrangements in Guangzhou and Sendai. The heat gains on the vertical surfaces are increasing as building distance increases. In the short building distance (10m to 30m), the heat gains on the east and west surfaces far more exceed those on the north and south surfaces. As the building distance gets greater, with the effects of building shadow becoming less, the heat gain on each vertical surface is becoming more, and the differences among the vertical surfaces are becoming less.

Fig. 8 shows the radiation heat gain of one building in different building arrangements in Guangzhou and Sendai. As seen from it, the heat gain of the building increases as building distance increases. In the 10m cases, the radiation heat gains in Guangzhou and Sendai are at the same level, but in the 60m cases, the heat gain of the building in Guangzhou is more than that in Sendai.

Fig. 9 shows the radiation heat gain of all the buildings in the target area in different arrangements. As seen from it, the total radiation heat gains of the buildings are apparently decreases as the building distance gets larger. With the building distance changing from 10m to 60m, the amount of the buildings in the target area decreases. This makes the radiation heat gain of the whole target area become less as building distance increases, though the heat gain of one building grows with an

increase in building distance. The total radiation heat gain of all the buildings in the target area in Guangzhou is a little more than that in Sendai.

CONCLUSIONS

(1) The shortwave radiation heat gain mainly depends on the exposure level of the surfaces to the sunshine. The longwave radiation heat emission mainly depends on the amount of the shortwave radiation absorbed by the surfaces.

(2) The ratio of the roof surface area to the whole building surface area is relatively small and therefore it is necessary to assess the reduction potential of cooling load by considering both the intensity of the net radiation heat gain and the area of the corresponding surface.

(3) The net radiation heat gains of the vertical surfaces for one building decrease as building distance decreases, however, the total net radiation heat gains of all buildings in the target area increase. With regard to energy consumption in a certain area, controlling the heat gain of the whole buildings is more important compared with that of a single building.

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