Form, Use and Clearing of Snow from the Gangi in Winter
-Study on the Common Space Design of Public Apartment Houses in Heavy Snowfall Areas in Japan

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Abstract
There are a large number of apartment houses equipped with Gangi, a kind of linked corridor which connects many buildings, in northern Japan, that are provided mainly for winter use. We analyzed continued and open form as they relate to snow protection. From the resident's point of view, our research clarified how to use Gangi in real life, how to remove the snow and also what is required for housing. Accordingly we arranged the problems and subjects of new house planning for the northern region. Finally, we tried to clarify the ideal image of Gangi and the common amenity space for apartment houses, and proposed some new design ideas.

Keywords: Gangi; Public apartment house; Common space; Site planning; Snowy region

Introduction
In recent years it has become increasingly common to equip the linked corridor called "Gangi", used mainly by public apartment buildings, with roofs in the snowy districts. Originally Gangi meant linked wooden eaves in front of a shop to keep the shopping street free from snow in the winter season. They are seen in snowy regions like Hokkaido and Tohoku, in the northern region of Japan, and were traditionally called Gangi or Komise (photo1).

The Gangi is a traditional covered sidewalk seen in wet snowy area in Japan. People can walk in Gangi safely and comfortably in heavy snow. When the snow is very deep, the road and Gangi are buried and a tunnel is dug to the other side of the road. Komise is the traditional covered sidewalk used in dry snow and windy areas in winter. The Komise, which is closed by temporary doors in winter, is different from the Gangi.

Here we will discuss the collective housing Gangi, which are different from the traditional Gangi. The current Gangi is fire-proof and different in form, but has the same purpose, which is to protect from snow. More over Gangi for apartment houses are used every day as a link between the apartment and common facilities. It is also used for storage and as a community space throughout the year, and plays an important role for indoor life or half indoor life in snowy regions.

From this point of view, we focused on the Hokkaido and Tohoku regions where many apartment houses equipped with modern Gangi are built. Hokkaido is a prefecture in the north of Japan, it receives a lot of snow and is extremely cold. Its climate is similar to that of Northern European countries.

Our research tried to analyze the continued and open form relating to snow protection. Next, from the resident's point of view, our research clarified how to use Gangi in real life, how to remove the snow and also what would be required for housing. Finally, through this research, we tried to clarify the ideal image of Gangi and the common amenity space for the apartment house focusing on protecting against snow and activating community life for residents. Studies on Gangi in apartment houses have been rather scarce. A short time ago, reports were published by Noguchi¹) and Nishimura²) on the use of Gangi in the Hokuriku area. In their reports, they examined the style and availability of Gangi in town houses. As regards the use of Gangi in public apartment houses, it has only been examined by the author of the present paper and several other researchers. These reports include "Study on the introduction of Gangi and its style in conjoined houses in Hokkaido", "Analysis of the peculiarities of style of Gangi in public apartment houses in Hokkaido and Aomori prefectures", and "Study on the availability of Gangi in public apartment houses in Hokkaido and Aomori". Drawing on these studies, the present report will examine more closely the possibilities of using Gangi in apartment houses.

The Method of Research and Survey
As a first step, we collected drawings of public apartment houses equipped with Gangi. They were collected from the total of 85 apartment housing estates in Hokkaido and three in Aomori prefecture.
They are drawings of the site plan, floor plan, elevation, and section. The form of Gangi was analyzed by these drawings of 88 housing estates. First, the feature of the continuity and the form of housing with Gangi were investigated. They are sorted into two groups-[Gangi connecting buildings], which connect between a building and another building and [Gangi attached to a building on the ground floor of an apartment building. We further classified them by their form and level of openness. Based on the previous classification, the questionnaire and observation were conducted for each group on six typical collective housing estates (three in Hokkaido and three in Aomori) (table 1).

The Continuity of Gangi Equipped to Apartment Houses

Gangi equipped to public apartment houses are generally sorted into three types (1: complete connection, 2: connected in part, 3: no connection) by the level of continuity and into two types (1: connected in a line, 2: connected at a right angle) by its linked form (figure 1.). Regarding the level of continuity, the non-continued type represents more than half of the total (88 housing estates) while 15 collective housing estates have the complete continued type, about half the number of the collective housing estates which have the linked Gangi.

Next concerns the features of the linked form. If it is connected in a line, only two to four buildings can be connected. In the case that the building is connected with Gangi at a right-angle, it not only connects buildings but also passes through spaces like parks and the courtyards where people gather. This linear type is difficult to connect to all buildings in a collective housing estate which has many buildings. Two to four buildings are connected, but are separated from the next. The rectangular type is able to connect all buildings. Many of them are perfectly connected.

The Form of Gangi and Their Openings

First, we will discuss Gangi connected to the buildings. We researched 16 collective housing estates with a total of 30 continuous types with Gangi connected to the buildings. The linear type, which is regarded as the extension of Gangi attached to a building, are excluded. They are classified into four types according to the degree of openness. The four types are: 1: both sides open, 2: both sides open with skirting board, 3: one side open, 4: one side open with skirting board.

The both-side open type are the majority in Hokkaido, and present more than half. On the other hand, the one side open type only appears in Aomori, not in Hokkaido. In Aomori we found that the parks or courtyards of buildings are surrounded by combinations of the one-side open Gangi attached to a building and the right-angle connection of Gangi.

Next, regarding Gangi attached to a building, we chose 76 collective housing estates to fit this survey. They are classified into three groups: 1: one side open, 2: one side open with skirting board, 3: mixed type) by the level of openness of Gangi space. Most Gangi attached to a building are set on the north side of the building because the sunlight from the south is important for the housing. For this reason, many of them are cold and dark. The most common, more than half, are the one-side open with skirting board type.

Gangi as a Passage

As regards six housing estates we investigated, both-types of Gangi connecting buildings (in four collective housing estates) and Gangi attached to a building (in six collective housing estates) are well used for passage. For Gangi connecting buildings, the questionnaire shows that, "often use" and "sometimes use" make up more than 70% altogether (table 2.). There is no big difference between Hokkaido and Aomori. Daisan Toyama are not used so much, which is why there are many buildings which are not connected to Gangi compared with other collective housing estates. According to the questionnaire, "When do you use it", the local residents answered as follows. Seventy percent are always using them and thirty percent use them in both rain and snow. It means they are using them at any time, even though this facility aims to protect from snow.

Table 1. Outline of housing estates and research of the questionnaire

| Region (prefecture) | Housing estates | City         | Total households (homes) | Average family size (persons) | Average household age (years) | Questionnaire (homes) | Answer (ratio) (homes) |
|---------------------|-----------------|--------------|--------------------------|-----------------------------|-------------------------------|-----------------------|-----------------------|
| Hokkaido            | Ooasa           | Ebetsu       | 127                      | 2.7                         | 60.8                          | 109                   | 69 (63.3%)            |
|                     | Hinode kita     | Iwamizawa    | 64                       | 3.0                         | 39.6                          | 45                    | 28 (62.2%)            |
|                     | Hinode Minami   | Iwamizawa    | 54                       | 1.8                         | 57.7                          | 30                    | 21 (70.0%)            |
| Aomori              | Daisan Toyama   | Aomori       | 213                      | 3.7                         | 33.9                          | 71                    | 59 (83.1%)            |
|                     | Miyazono        | Hirosaki     | 204                      | 3.3                         | 34.7                          | 77                    | 67 (87.0%)            |
|                     | Jousai          | Hirosaki     | 200                      | 3.1                         | 43.8                          | 76                    | 61 (80.3%)            |
| Total               |                 |              | 862                      | 3.1                         | 36.4                          | 408                   | 305 (74.8%)           |
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#### Abstract

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#### References

**Jousando**

| Housing estates | Gangi connecting buildings | Gangi attached to a building |
|-----------------|-----------------------------|-------------------------------|
| Ooasa           | Gangi pass through buildings and open space in the center area. All buildings are connected in a tree shape. | There is no wall on both sides in Gangi created as a part of open space. | Mixed type with one side open (access free outside) and indoors. |
| Complete connection | Both sides open (3.0m width) | One side open with skirtiing board (2.0m width) |
| Hinode Kita     | The straight Gangi passes through all the buildings. There is a gap of height between the Gangi and open space. | Both sides are open, but skirtiing board prevents access to courtyard. | There are only storage rooms on the ground floor. It is open, but not possible to walk through. |
| Complete connection | Both sides open with skirtiing board (2.4m width) | One side open with skirtiing board (2.4m width) |
| Hinode Minami   | There are no Gangi which connect to the buildings. Buildings are not connected by Gangi. | No Gangi connecting buildings | Access free to courtyard |
| No connection   | |
| Aoanori         | | |
| Daisan Toyama   | Gangi pass through the center area. A few buildings are connected by Gangi. | Benches are set at one-side of the open Gangi Free access to courtyard. | Bicycle parking space and storage are located on the opposite side of dwelling units. |
| Connected in part | One side open (3.0m width) | One side open with skirtiing board (1.7m width) |
| Miyazono        | A few buildings are connected in line each. | Many small Gangi are arranged in line between two buildings | Gangi spaces are wide and occupied by full of daily commodities. |
| Connected in part | Both sides open (2.4m width) | One side open with skirtiing board (2.4m width) |
| Jousai          | Gangi pass along the side of each building. The courtyard is surrounded by Gangi and buildings. | Gangi pass along the side of building and connect to all buildings. | Gangi has skirtiing board. Spaces are wide and occupied by daily necessities. |
| Complete connection at right-angle | One side open (2.5m width) | One side open with skirtiing board (2.4m width) |

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**Fig. 1. The feature of the site plan in the housing estates and the form of Gangi**
Gangi as a Common Living Space

Gangi are not only used as a passage, both types are used in the same way; to "chat with neighbors" and "for children to play". The eaves create a community space for the residents (photos 3 and 4). Gangi connecting buildings in Daisan Toyama are used as a children's play area; 50% of its total use (figure 2). The space of Gangi is good enough and suitable for children to play. In the case of Hinode Kita it is used a lot for children's play. One of the main reasons is that there is a park beside it (photo 2). A high percentage of Gangi connecting buildings particularly are used for "taking a walk", "enjoying the cool of evening or break". "Taking a walk" represents 30% to 40% and "enjoying the cool of evening or a break" is 10% to 20% at any collective housing estate.

During the interview survey, we often heard; "it's good to enjoy walking on a rainy day and for children to play outside". On the other hand, Gangi attached to a building are used a lot for "bicycle parking". In three collective housing estates in Aomori particularly, its use as "bicycle parking" is 50% - 70%. This depends on whether they were planned as bicycle parking space from the beginning with a width of 2.4m (photo 5). On the other hand in the case of three collective housing estates in Hokkaido, it is only 0 to 20%. This is because they have independent bicycle parking space and the Gangi is narrow at 2m width compared with Aomori. In the case of Ooasa, the Gangi are indoors.

Form and use of Gangi in different seasons

The Gangi is also used as a place for socializing, where housewives can chat, children can play, and some residents can do light work. Thus, it is much more than just a passageway, it is also a meeting place for the residents, where they can get together regardless of the sunlight, rain, cold winds, or snow in winter.

The next figure demonstrates different ways of using the courtyard adjacent to Gangi in the Daisan Toyama complex depending on the season (figure 3). In summer, for example, the Gangi often functions as an open space for "chatting with neighbors", "children playing", "taking walks", and "doing everyday chores". In winter, only the Gangi is used for "chatting with neighbors", "children playing", and "taking walks".

Table 2. Use of passage in Gangi (connecting buildings) (household)

| Housing estates | Used often | Used sometimes | Not used much | Unused | Total |
|-----------------|------------|----------------|---------------|--------|-------|
| Ooasa           | 36 (52.2%) | 21 (30.4%)     | 5 (7.2%)      | 7 (10.1%) | 69 (100.0%) |
| Hinode kita     | 15 (53.5%) | 5 (17.9%)      | 4 (14.3%)     | 4 (14.3%) | 28 (100.0%) |
| Daisan Toyama   | 16 (27.1%) | 21 (35.6%)     | 6 (10.2%)     | 16 (27.1%) | 59 (100.0%) |
| Jousai          | 36 (46.8%) | 15 (19.5%)     | 11 (14.3%)    | 15 (19.5%) | 77 (100.0%) |
| Total           | 103 (44.2%)| 62 (26.6%)     | 26 (11.1%)    | 60 (18.0%) | 233 (100.0%) |
How to Remove Snow from the Gangi Space

In winter, however, the area around the building is practically on the same level facilitates its use. Also, the fact that Gangi and the courtyard are between Gangi, the adjacent courtyard and the open space. Here mothers can sit on the benches by the wall watching their children play without worrying. In addition, there is no place to hide between Gangi, the adjacent courtyard and the open space. Also, the fact that Gangi and the courtyard are practically on the same level facilitates its use.

In winter, however, the area around the building is covered with snow, and the courtyard is barely accessible. As a result, the Gangi plays a prominent role in the residents lives, since it is not affected by snowstorms. Nevertheless, it is not used to the same extent as in the summertime, for instance, as a place for the housewives to engage in gossip, even though the semi-open Gangi provides shelter from snowstorms and can still be used as a passage and a place for children's activities. In order to make Gangi more functional and usable in winter, it is essential that it be indoors. It is also advisable to keep it at room temperature so that residents can use it for longer periods of time.

How to Remove Snow from the Gangi Space

The Gangi has the purpose to maintain a passage during the snowy season, but as long as it is not an indoor type, it has problems of the snow coming in (photos 6 to 8). The questionnaire shows that, when the Gangi is connected to buildings, over 90% answer "snow blow in" (table 3). "Snow blows in and stays" is also outstanding at high percentages. At two estates in Hokkaido, particularly, it is over 80%. It depends on how many of these two estates have only both-side open Gangi without any protection against the snow. On the other hand, "Snow blows in and stays" represents about 50% in Aomori, which is less than Hokkaido. This results from the form of Gangi connecting buildings in Aomori, which are different from Hokkaido. In Aomori, one side of the Gangi is closed. The one-side closed type keeps the snow out more than the both-sides open type. In Aomori, the side to be closed is also confirmed considering the wind in winter.

In the case of Gangi attached to a building, "Snow blows in" is about 90% of the total, and "Snow stays" is about 60% of these. As the one side is a building, the percentage of "Snow blow in and stay" is a little less than Gangi connecting buildings. In this case, there is no big difference between Hokkaido and Aomori. Both types of Gangi need snow clearing because the snow blows in and stays(photos 7 and 8). With Gangi connecting buildings, the necessity of clearing the snow is 90% to 100% in Hokkaido and 20% to 60% in Aomori, the difference depends on the estates. The need for clearing the snow is higher in Hokkaido because of it's open form. They have further problems of frozen floors caused by snow. The Gangi currently has a big problem in maintaining a safe passage in winter.

Use of Gangi and conditions of snow removal in winter

As mentioned earlier, a lot of residents report using Gangi as a passageway in summer and winter respectively. These figures indicate that Gangi functioned well enough to provide a walkway which

| Housing estates | Snow blow in and stay | Snow blows in and stays | No snow | Total |
|-----------------|-----------------------|-------------------------|--------|-------|
| Ooasa           | 60 (86.9%)            | 9 (13.0%)               | 0 (0.0%)| 69 (100.0%)|
| Hinode kita     | 24 (85.7%)            | 4 (14.3%)               | 0 (0.0%)| 28 (100.0%)|
| Daisan Toyama   | 31 (52.5%)            | 26 (44.1%)              | 2 (3.4%)| 59 (100.0%)|
| Jousai          | 41 (53.2%)            | 31 (40.3%)              | 5 (6.5%)| 77 (100.0%)|
| Total           | 156 (67.0%)           | 70 (30.0%)              | 7 (3.0%)| 233 (100.0%)|
would otherwise be impassable in winter due to the snow. Let us consider as an example Jousai houses, where the Gangi runs the entire length of buildings, and Daisan Toyama houses, where only some of the apartments are adjacent to the Gangi (figure 4.). This will enable us to examine the extent to which the Gangi is used by the residents of each apartment and how this affects snow removal around the building in winter. Apparently, if the Gangi serves its purpose, the area to be cleared of snow will be considerably reduced. By examining how often residents of each apartment use the Gangi in winter and the conditions of snow removal in figure 4, we can see that residents of the Daisan Toyama apartments use the Gangi to a lesser extent than the Jousai residents. Residents of apartments not adjacent to the Gangi appear to use the Gangi the least, as a result, snow has to be removed around the building to clear a passage for the residents and this, in turn, results in a large number of snow-cleared roads in the area.

In contrast, in Jousai, where the Gangi runs the entire length of buildings, residents report a heavier use of the passageway, and as a result, we cannot find snow-cleared roads in the area. As figure 4 suggests, clearing snow will be less of a burden and there will be no snow-cleared roads, if the residents use the Gangi. Further, let us take a closer look at the open space around the buildings and see how snow accumulates on the roads as a result of snow removal. It is apparent that in both complexes, the shortest way to the apartments as well as the parking lots is by using the Gangi. This is particularly noticeable in the Daisan Toyama building. In the Jousai complex, where the Gangi is effectively used, there are two roads providing the easiest access to the building. Generally speaking, the Gangi should be introduced according to the residents needs. However, one should keep in mind that the introduction of Gangi in this way will result in its heavy use by residents as a passageway. Thus, it would be best, at least initially, to keep the existing roads in good condition, and then let the residents decide how the space should be utilized.

**Resident's Requirements regarding the Gangi**

The Gangi is often used in various ways, but residents are not always satisfied. "Satisfaction" is only 50% for both types of Gangi. In the case of Gangi connected to buildings, the three main reasons of dissatisfaction are "snow blows in", "snow stays" and "cold" in both of the regions. For Gangi attached to a building, the reasons are "snow blows in", "snow stays" while others are "narrow", "cold", and "noisy". This applies to most of the Gangi attached to a building located on the north side of a building and which are not always wide. Also the windows of some dwelling units face to the Gangi (photo 5). Compared to each region, the value of the Gangi connected to buildings in Hokakido is significantly low. As the one side is not closed like the Gangi in Aomori, snow easily to blows in and as a result the floors of the Gangi becomes frozen and slippery.

On the contrary, the value of Gangi attached to a building is lower in Aomori. This is caused by the Gangi being used as a bicycle parking space. Resident's

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**Fig. 4. Frequency of the Gangi used as a passageway and actual conditions of clearing snow on the premises in winter**

- **○**: 60% or more of the apartment residents report "always using it"
- **△**: 60% or more of the apartment residents report "always using it" or "using it only when it rains or snows"
- **×**: Less than 60% of apartment residents report "always using it" or "using it only when it rains or snows"

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requirements for Gangi are "should be more comfortable for the children to play" (average 31% of the total), "need some benches for rest" (28%), "should be indoors to avoid the snow" (25%), and "should receive more sunshine" (19%).

Conclusion
The feature of continuity is important for the Gangi. However there are rather few Gangi which connect all of the buildings in collective housing estates. If the Gangi falls at right angles to a building, it is easy to create a compact and calm space. Particularly in Aomori, the one-side open Gangi which connects and is arranged at right angles to buildings are creating the preferred space between buildings. In Hokkaido, there are no one-side open Gangi connected to buildings. The both-side open without walls are the majority. For this reason, there are no spaces created by the Gangi as in Aomori. Most of the Gangi are attached to the north side of the building, and are dark and cold in many cases. Many of them are open with a skirting board.

The Gangi is well used not only as a passage space but also as a common space for residents. The fuction of the Gangi appears to be for the purpose of going to work or school on a raining or snowing day, children's play and going for a walk. The form of Gangi is different in Hokkaido and Aomori. For this reason, the characteristic differences in the way of use and resident's satisfaction are seen. Residents in both regions are not satisfied with Gangi so far.

It should be much improved. In trying to improve the Gangi for apartment houses as a living space to suit the snowy region, we should develop a design in which the snow does not blow in much or stop blowing in completely. We also should research the proper relationship between the building(dwelling unit) and Gangi considering for problems of noise and privacy. Further more we should plan flexible types, which are open in the summer time and enclosed in winter. We need to survey for the plan of the new common space with a combination of living space and linked passage to avoid the snow and cold.

Here are our proposals in this conclusion. The first proposal is an idea that the Gangi should be placed in the south instead of the north where they are usually located. It must be warm with much sunlight even in winter and people should want to gather there. According to this, we need to reconsider the plan for the dwelling unit and apartment building. For example we should develop the new design of dwelling units, that is an original maisonette unit and a unit facing the southward Gangi, etc. Secondly, we should use the Gangi as a multi-purpose living space. A warm space like an atrium could be suitable for the purpose as an activity space for meeting, playing, gardening etc., while adding the current purpose of passage and storage. Thirdly, we need more common facilities that connect to the Gangi, like the children's playroom and the multi purpose community room. Furthermore it is more important for the large collective housing estates to include a shopping area and welfare facilities for the aged. Collective housing in the northern regions should be changed to a new style. We think it important to establish a new theory for this project. A new theory and design will surely evolve in the near future.

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