



## PROTECTION OF EARTHQUAKE DAMAGED “JAPANESE” ROOFS BY BLUE TARPS (SHEETS) ~ A CASE STUDY ON SETTING CONDITIONS ~

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### *Abstract*

As the method of the temporary restoration of damaged house roofs, blue tarps (sheets) are often applied to cover the damaged area of the roofs (i.e. Fig.1). Local governments in Japan often distribute blue tarps for the people in affected area as a common public support in case of earthquake. However, the method of covering damaged roofs is not well established. Blue tarps on the roof can be deteriorated by sunshine, and it cannot be stable for long time. In addition, blue tarps can be fly out in case of rainstorm when the setting condition of the tarps are not well designed. Although some volunteer groups obtained some skills from trial and errors in the field, their skills and techniques are not well announced.

In this study, we investigated the characteristics of the blue tarps setting condition in Takatsuki City, Osaka, Japan, where an earthquake attacked in 2018. The roofs of 65 houses were investigated. The results showed the wide variety of the methods of covering damaged roofs. For example, the difference of soil bag to stabilize the tarps (black bags and white bags) were observed, and the black bags which have higher durability were used in only about 30% of damaged houses.

The results emphasized the necessity to clarify the appropriated style of damaged roof coverage. Establishment of the guideline of the appropriate covering of the roof assist the appropriate preparedness of the material for emergency temporary restoration. It will lead us to better public support for the affected area.

*Keywords: roof; blue tarps (blue sheets); temporary restoration; house; rainstorm*



Fig. 1 An example of earthquake damaged roof covered by blue tarps (sheets)



## 1. Introduction

Blue tarps (sheets) were often observed as the material for temporary restoration after an earthquake. For example, blue tarps covering damaged slopes are often observed as shown in Fig. 1. It was used to prevent successive failure of slope by stopping infiltration of rainfalls. In many cases, these blue tarps are stabilized by soil bags.

Application of blue tarps is not limited for slope stability issues. Roofs of damaged houses were also covered by blue tarps as shown in Fig. 2. As same as the usage of blue tarps on slopes, the blue tarps on roofs were often fixed by using the weight of soil bags. However, the stability of blue tarps on roofs is more critical issue than that of blue tarps on slopes. This is because the blue tarps on roofs may need more careful stabilization than that on slopes, considering strong winds on roofs and possible traffic under the roofs. Fig. 3 is an example of damaged blue tarps found on a street. This damage may be induced by inappropriate way of blue tarp stabilization.

However, it is not easy to stabilize the blue tarps on roof appropriately. Fig. 4 is an example of damaged roofs of a Japanese house. Japanese roofs are covered by roofing tiles, but the shape of roof is not simple. Roofing tiles of different shapes and sizes are used on top horizontal line of roofs and sloped flat roofs. Technically, there is no standard way of the application of blue tarps on roofs.

Some volunteer groups have much experiences of the application of blue tarps on damaged houses. However, usual peoples including local carpenters never experienced the work of blue tarps on roofs. This is because the temporary restoration of earthquake damaged roof is not a usual work. Due to the luck of experiences in local carpenters, there were some workshops on how to use blue tarps on damaged roofs, at the time of 2018 earthquake disaster in northern Osaka prefecture. These workshops were organized by volunteer groups, and participants of the workshop could share some techniques of using blue tarps appropriately, as shown in Fig. 5.

It suggests that the reality of the usage of blue tarps on roofs is not well organized. The techniques on the works are experience based. And both experienced engineer and non-experienced engineer work on the temporarily restoration at the affected area. And this situation make some houses inappropriately restored as shown in Fig. 3. It is necessary to establish a standard appropriate method of using blue tarps for damaged roofs.

In this study, a field survey was conducted to obtain the information on the reality of usage of blue tarps on damaged roofs. The target of the filed survey was the damaged houses in Takatuski City, in 2018 earthquake disaster of northern Osaka prefecture.



Fig. 1 An example of blue tarps (sheets) application to prevent successive failure of slopes



Fig. 2 An example of earthquake damaged roof covered by blue tarps (sheets)



Fig. 3 An example of blue tarps (sheets) inappropriately used on a damaged house



Fig. 4 An example of damaged roof and difference of roof tiles



Fig.5 An example of workshop on how to install blue tarps for temporary restoration

## 2. Variation of the condition on temporary roof restoration using tarps (sheets)

### 2.1 The viewpoint to check the variation of setting condition of tarps

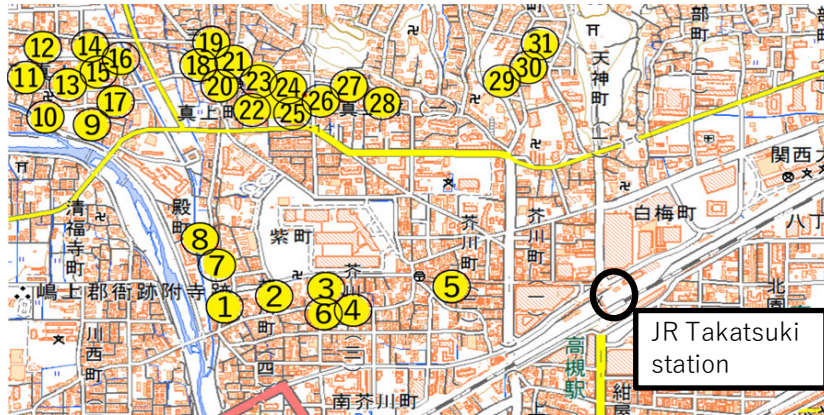
In order to check the variation of the setting condition of blue tarps, some damaged houses in 2018 earthquake in northern Osaka prefecture were investigated. The field survey was conducted on August to October, 2018, at the area located north west of JR Takatsuki station. Fig. 6 shows the location of houses with restored roof using tarps. Total 65 houses were investigated.

The setting condition of tarps (sheets) were categorized from the following viewpoints.

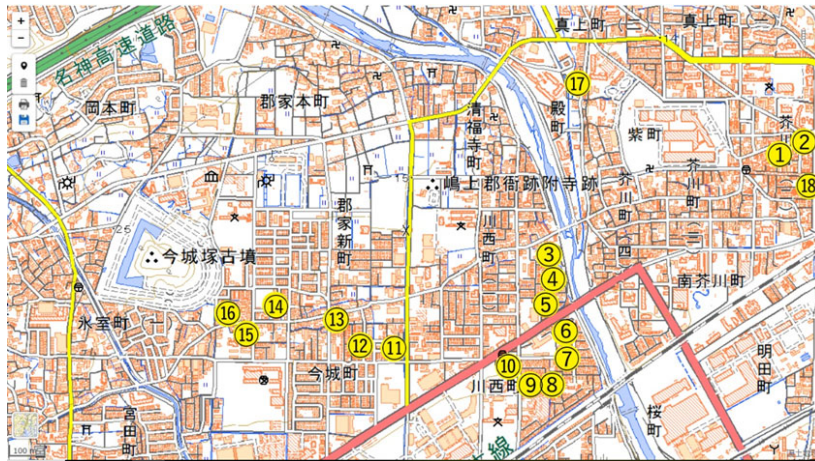
- (1) The color of tarps (sheets): Local government distributed blue tarps for the residents of damaged houses. However, there were some houses using the tarps of different colors. It may be since the number of distributed tarps was insufficient in some houses.
- (2) The location of tarps (sheets): The shape of roofs is not simple. And the location of the damaged roof tiles was different house to house. Therefore, the location of the tarps was also different. In some houses, the tarps covered the roofs completely, but in other houses, tarps were used on partially.
- (3) Usage of soil bags: In many cases, soil bags were used to stabilize the tarps. But there were some houses not using soil bags. In addition, the color of soil bags was not the same. Basically, black soil bag is more UV resistant and preferable.
- (4) Usage of ropes: In many cases, soil bags were connected each other with ropes. But there were 2 types of ropes: black and white. Basically, black rope is more UV resistant and preferable.
- (5) Usage of wooden plates/bars: Some volunteer group proposed the usage of wooden plates/bars to stabilize the tarps. Although a soil bag can push only a point of a tarp, wooden plates/bars can push an area/line on a tarp. Thus, it can prevent winds from entering under a tarp.

### 2.2 Variation on the color of tarps (sheets)

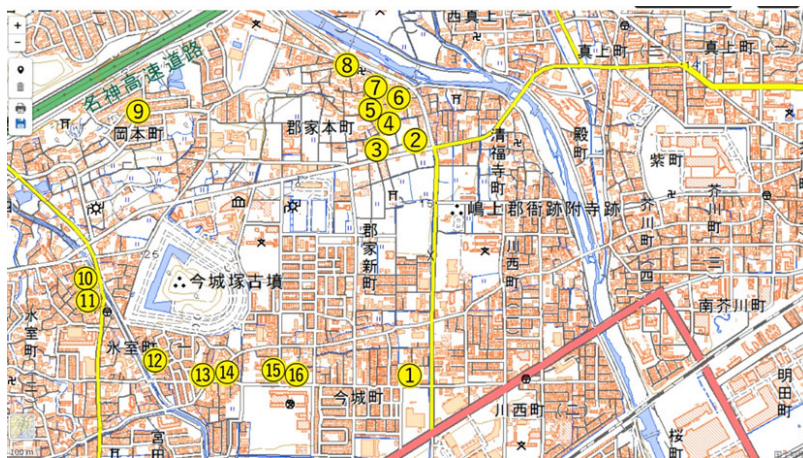
Fig. 7 is the summary of the color of tarps. Blue tarps were used in 94 % of the cases. This is because the blue tarp is an easy material to be obtained from a shop, and local government gave blue tarps to the people in damaged residences. But the fact that different colors were used in 6 % cases should be remembered if some researcher use the number of blue tarps as the index of damage level.



(a) Field survey at August, 2018



(b) Field survey at September, 2018



(c) Field survey at October, 2018

Fig.6 Location of the houses with restored roofs

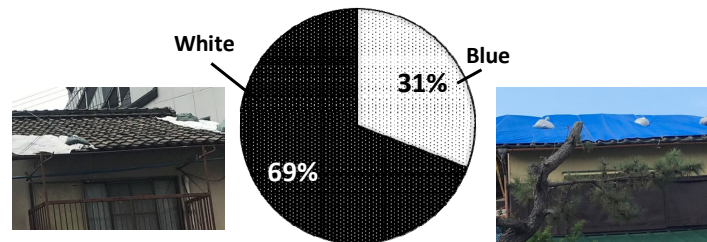


Fig. 7 The color of tarps (sheets)

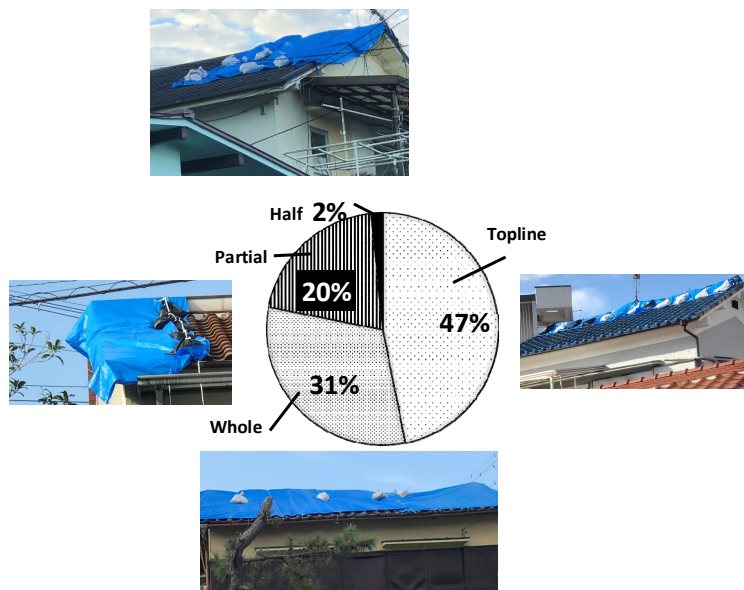


Fig. 8 The location of tarps on the roof

### 2.3 Variation on the location of tarps (sheets)

Fig. 8 is the summary of the location of tarps. More than half of the tarps were used for top line of the roofs. The damage characteristics of the roof tile may depend on the structure of roofs. In this 2018 northern Osaka prefecture earthquake disaster, many roofs of Japanese classic style houses were damaged. In Japanese style roofs, a roof tile in flat slope area is partially covered by another roof tile. Thus, the roof tile in flat slope area is stabilized. However, the roof tile at the top line is made as special shape, and it is not covered by other tiles. This is why there were many damage at the top line of the roofs. If the shaking was more strong, more roof tiles at the flat slope area may be damaged and the ratio of full covered tarps may be increased. Note the thickness of tarps were not checked in this field survey. Since the resistance of the tarp depends on the thickness of the tarps, it is preferable to develop a method to check the thickness of the tarp in future study.

### 2.4 Variation on the usage of soil bags

Fig. 9 is the summary on the usage of soil bags. Soil bags were used in more than 80 % of cases. White soil bags were used in 46 % of all the cases. The UV resistant black soil bags were used in only about 30 % cases. The main usage of white soil bag in usual is gathering of garbage in gardening activity, and construction of small embankment to prevent water inundation. In other words, application of white soil bag on damaged roofs is not designated purpose. Thus, it is important to promote UV resistant black soil bags more.

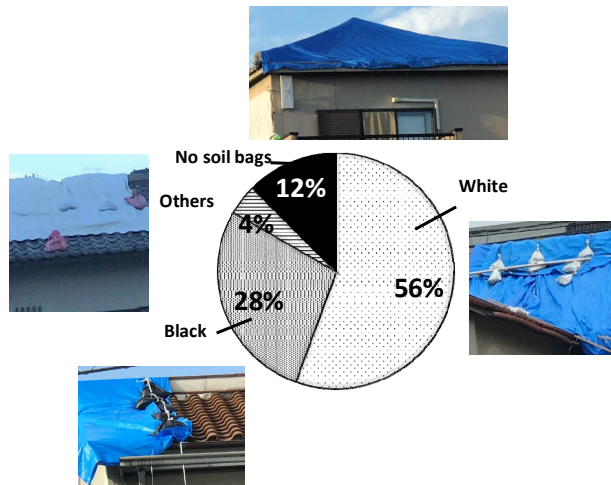


Fig. 9 The color of soil bags

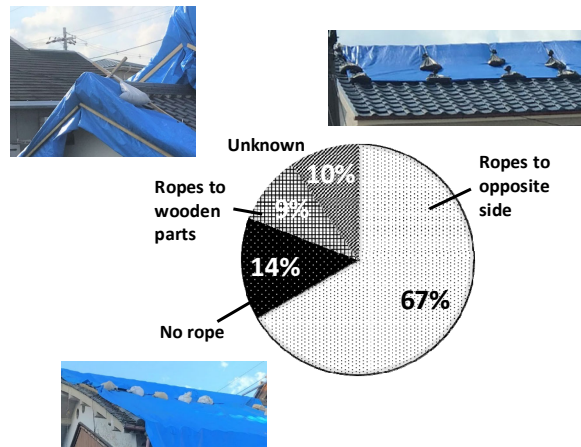


Fig. 10 The connection of ropes

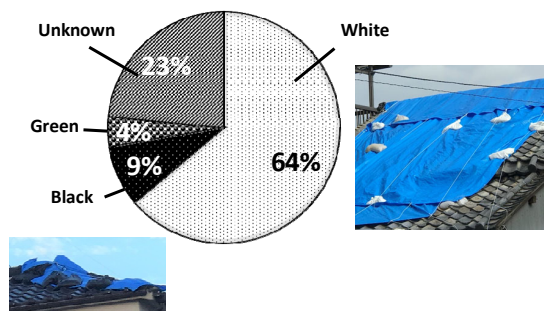


Fig. 11 The color of ropes

### 2.5 Variation on the usage of ropes

Fig. 10 show how the ropes were used. In most cases, the rope of soil bags was connected to something in the opposite side. Although the opposite side of roof is not visually checked, it may be connected to a counter weight soil bag. In around 10 % of cases, the ropes were connected to wooden structure.

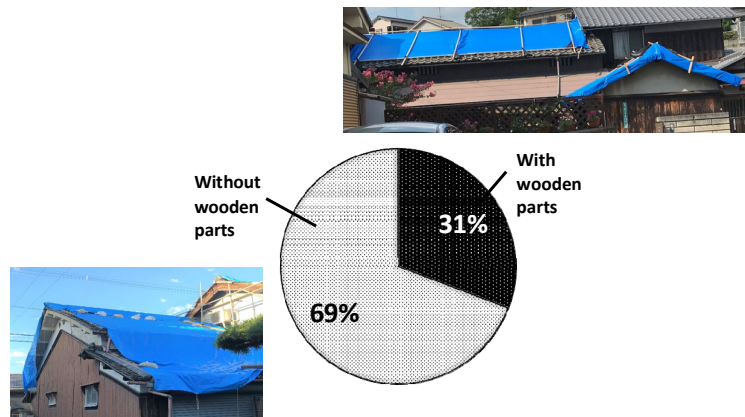


Fig. 12 The application of wooden plates/bars

Fig. 11 is the summary of colors of ropes. In about a half of cases, white rope was used. As same as soil bags, black ropes are UV resistant and preferable. The major use of the white rope in usual is to tie garbage such as cardboard/newspapers. Again, application of white ropes on damaged roofs is not designated purpose. Thus, it is important to promote UV resistant black ropes more.

### 2.6 Variation on the usage of wooden plate/bar

Fig. 12 is the summary of the usage of wooden plates/bars. In about a half cases, wooden plates/bars were used. Since the shape of Japanese roof is complicated, it is not easy to construct a wooden structure on roofs. Skilled engineer is necessary to install wooden plates/bars appropriately.

## 3. Monitoring of damaged houses

In order to clarify the appropriate method to stabilize tarps on roofs, monitoring of damaged houses was conducted. The targets of the monitoring were selected from the area around JR Takatsuki station and Kansai University (Takatsuki Muse Campus). The locations of the houses were shown in Fig. 13. Total 20 houses were selected as the target of the monitoring. The monitoring was done at November/December 2018 as the first time, March 2019 as the second time, and August 2019 as the third time.

The summary of the progress in restoration is shown in Fig.14. Only a half of houses were restored. There are 2 houses (10%) removed after disaster. Thus, 40 % of all houses were not restored even after one year from the disaster. The delay of restoration come from many reasons. Settsu City did a questionnaire survey on the progress of restoration [1]. In the survey conducted at July, 2019, about the 40 % of not-yet-recovered case is due to the difficulty in the scheduling of the carpenters. But in about 30 % of cases, they did not decide whether the house shall be restored or not. It implied that the many damaged house, which are often old aged, are vacant or planned to be vacant soon. The management of these unused houses is a critical issue for the safety of local society in Japan.

The owner of houses may not imagine that the restoration takes such a long time. Since it took more than one year in many houses for restoration, some maintenance works were necessary for tarps in some houses. Fig. 15 shows an evidence of maintenance work for tarps on a roof.

The authors thought the information of maintenance work in monitoring period and the categorization of setting condition of tarps may give us an idea of appropriate setting method of tarps on roofs from the viewpoint of the resistance. Table 1 is the summary of the setting condition for the cases with and without maintenance works. However, 7 houses were completely fixed in the second survey, and these cases cannot be used. Also, one house is completely abandoned without considering the maintenance of tarps. Thus, only





12 houses can be used for discussion. In summary, 6 cases are with maintenance works, and 6 cases are without maintenance works.

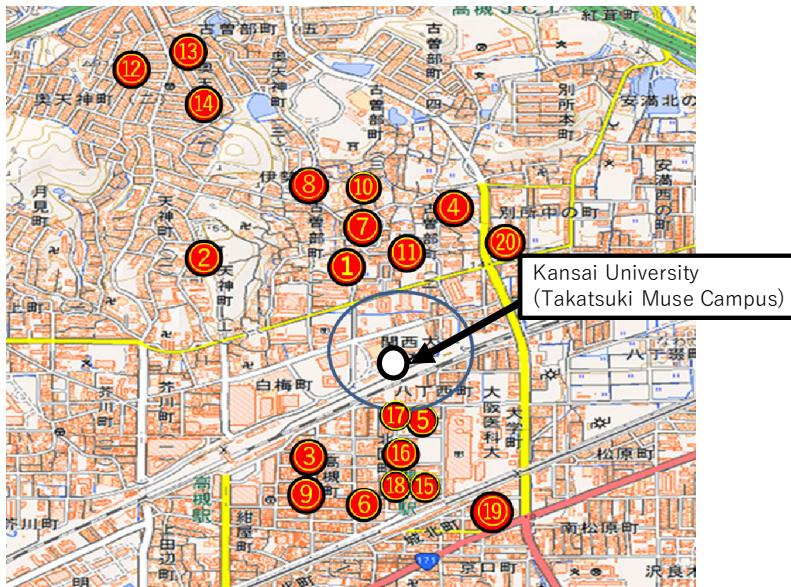


Fig.13 Location of the houses for monitoring (field survey started at November, 2018)

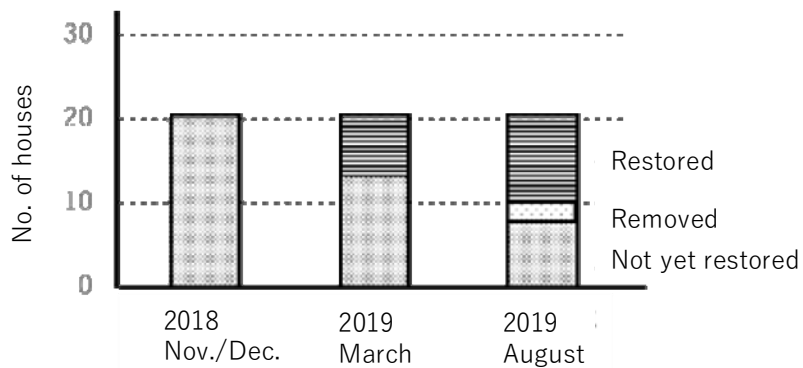


Fig.14 Progress of restoration in monitored houses

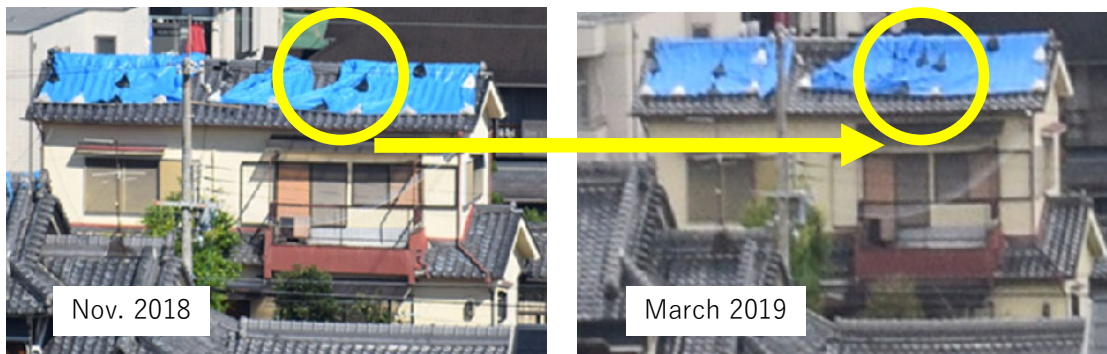


Fig.15 An example of maintenance work for tarps on a roof



Table 1 Summary of the monitoring focusing the setting condition of tarps and maintenance works

		With maintenance works	Without maintenance works
Soil bag	None	0	1
	White	4	3
	Black	1	1
	Both (B/W)	1	1
Wooden plates/bars	With	1	1
	Without	5	5
Ropes	With	3	3
	Without	3	3

It is a surprising that a house without soil bag did not need maintenance. Although it is a common to use soil bags for stabilization of tarps, the usage of soil bags is not mandatory. Stabilization of tarps by wooden parts and ropes may give more stability on tarps. In other aspects such as the colors of soil bags, usage of wooden plates/bars and ropes, there is no difference between the cases with maintenance and the cases without maintenances. This is maybe because the number of houses in the monitoring is insufficient.

#### 4. Conclusion

In this study, we investigated the characteristics of the blue tarps (sheets) setting condition for roof temporary restoration in Takatsuki City, Osaka, Japan, where an earthquake attacked in 2018. The roofs of 65 houses were investigated. The results showed the wide variety of the methods of covering damaged roofs. Also, monitoring of some houses for one year reveals that about 40 % of houses are not yet restored even after one year from the disaster. Due to insufficient number of monitored house, the relationship between the resistance of the tarps of roof and its setting condition cannot be clarified. But there is a case that a house not using soil bags can be kept in good condition without doing maintenance. It suggests that the usage of soil bags is not mandatory, and stabilization of tarps by wooden parts and ropes may give more stability on tarps.

The results emphasized the necessity to clarify the appropriated style of damaged roof coverage. Establishment of the guideline of the appropriate covering of the roof assist the appropriate preparedness of the material for emergency temporary restoration. It will lead us to better public support for the affected area.

#### Acknowledgement

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#### Reference

- [1] Settsu City (2019): A questionnaire survey results for the residence in damaged house in 2018 earthquake disaster in northern Osaka prefecture, <https://www.city.settsu.osaka.jp/material/files/group/61/osakanorth.pdf> (Accessed at January 27, 2020) (in Japanese)