Analysis of the Differences Between the Design and Construction of Temporary Houses for Semeru Eruption Disaster in 2021

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Abstract. This study was prepared to determine the difference between design and construction of Temporary Houses for post-disaster Semeru eruption in 2021. From the design documents and actual construction on the site, there are some changes, and the factors that influence these changes can be seen. The eruption of Semeru at the end of 2021 caused several areas in Lumajang Regency damage and the community had to be relocated to new places that were considered safer and feasible. The accelerated relocation program is accompanied by a Temporary Houses design concept provided by Indonesian Architect Association (IAI) East Java region. However, along the way, there are several adjustments to support post-disaster rehabilitation acceleration programs. The focus of temporary housing is fast, cheap, safe, and can be mass-produced. From this study, factors that influence the design adjustment are Site Condition, Number of Building Units, Material Availability, Human Resources, and Government Policies and Policies. Design adjustments have occurred very often, such as in the construction of common buildings, there are planning documents, known as detailed engineering drawings (DED), then there are adjustments to site conditions, becoming shop drawings (drawings that will be implemented) and finally, there are drawings according to the building being built, as-built drawing.

Keywords: Differences · Desain · Construction · Temporary · Houses · Post-Disaster · Semeru Eruption

1 Introduction

The eruption of Mount Semeru again occurred on December 4, 2021. Volcanic ash and cold lava led to the north side of Mount Semeru and caused five sub-districts in Lumajang Regency to be severely affected. The five sub-districts are Candipuro, Pasrujambe, Senduro, Gucialit, and Pasirian District. There are dead and injured and there are still others who have not been found [1]. The Gladak Perak Bridge, a bridge connecting the southern route between Lumajang and Malang Regencies, was cut off due to the cold lava of the volcanic eruption. Pyroclastic flows and lahars damaged at least 5,205 houses

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Fig. 1. Temporary Houses relocation area in Sumbermujur Village, Candipuro District

and several public buildings. As of December 9, 2021, the National Disaster Management Agency (BNPB) reported that 2,970 houses were damaged and 3,026 livestock died. Other damage included 42 units of educational facilities, 17 religious facilities, 1 health facility, and 1 bridge [2].

Therefore, the Lumajang Regency Government relocated the affected areas. The relocation is in Oro-Oro Ombo Village, Pronojiwo District with a proposed area of 9.44 Ha, and Sumbermujur Village, Candipuro District with an area of 81.55 Ha for the planned construction of 2000 temporary housing units and permanent houses [3] (Fig. 1).

2 Temporary Houses Design

Temporary Houses Design has a concentration of concepts on buildings that are quickly built, can be built easily, materials available on the market or local materials, have low construction costs and of course, must be safe. Overall, post-disaster areas and buildings are buildings that must comply with Resilience Design rules; Disaster – Response – Recovery – Mitigation -Preparedness [4].

2.1 Temporary Houses Design Concept

Temporary Houses (Hunian Sementara/Huntara) were originally designed by the Indonesian Architects Association (IAI) in the East Java region and then developed and adapted on the site by the local government. The shelter design concept focuses on two aspects; 1) Healing Home, creating a temporary shelter with a rural feel like the previous village as well as housing that can be used as a healing place for trauma after the eruption of

Fig. 2. Temporary housing design concept by IAI East Java region.

Mount Semeru. The concept of a healing home can also be extended to an environmental scale so that it can create an atmosphere and culture of trauma recovery that is even and simultaneously post-disaster [5]. 2) Re-use Materials; Reusing materials that are no longer used or carried away during the eruption into more useful things, such as used roof tiles, tile fragments, bamboo, wood, and the addition of elements of color and vegetation [6] (Figs. 2 and 3).

2.2 Temporary Houses Materials

This temporary house is designed with a length of 4.8 m and a width of 6 m, consisting of a terrace, dining room (main), bedroom, kitchen, bathroom, and clothesline (side terrace). For the structure of the columns, beams, and roof trusses using mild steel, galvalume C profile 350 × 750 mm, floors using plaster and plaster finishing concrete rebar, walls using kalsiboard measuring 120 × 240 cm, ceilings using gypsum board measuring 120 × 240 cm, roofing using spandex. As for the door and window frames, we use a canal C galvalume frame and multiplex wood planks for the cover (Fig. 4).

2.3 Temporary Houses Structure Huntara

The design of the temporary house, in addition to being planned with the concept of Healing Home and Re-use Material, must also consider the post-disaster aspect itself, namely prioritizing aspects of time and cost efficiency as well as safety. Time here means how buildings can be built in a fairly short time span and are easy to apply or implement by local workers and volunteers. Meanwhile, costs are related to the availability of materials, cheap materials, and standard building sizes for post-disaster housing (Fig. 5).

2.3.1 Sub Structure

In the design document of the shelter, the lower structure is not explained, but from the description of the structure and material, the bottom is a floor that uses a cement plaster

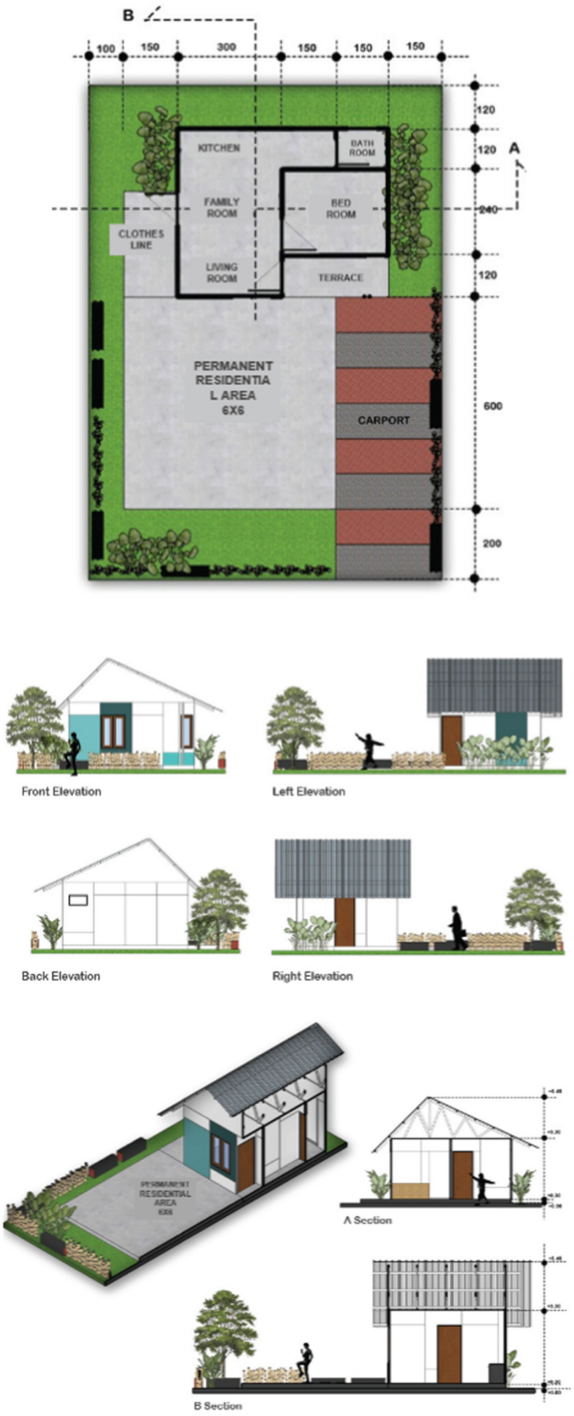

Fig. 3. Temporary housing design by IAI East Java region.

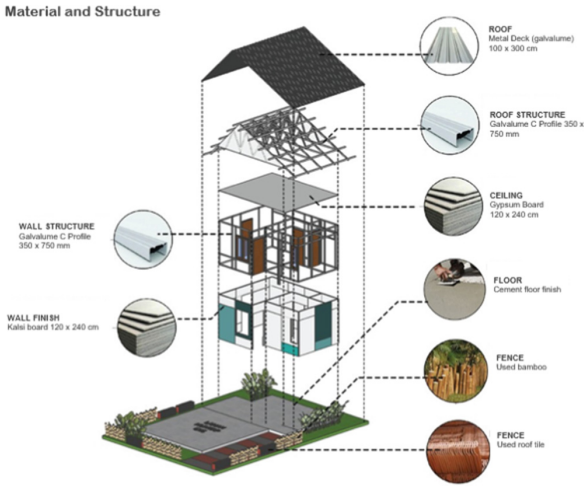

Fig. 4. Materials used in Temporary Houses buildings.

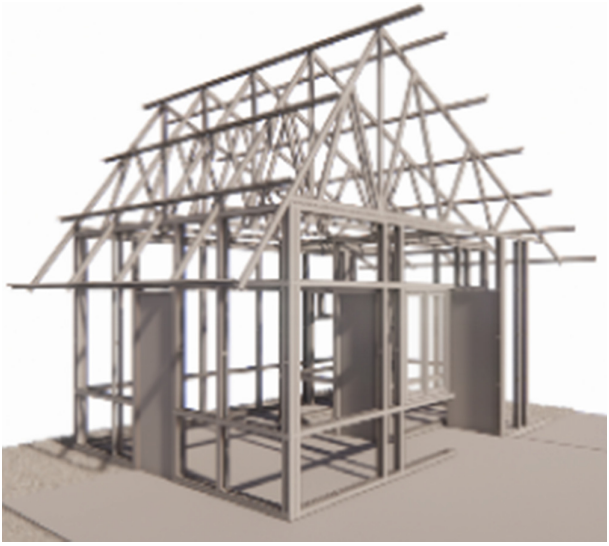

Fig. 5. Structures used in temporary housing.

finish. Thus, the bottom structure for the perimeter of the edges uses a pair of river stones, and in the middle is earthfill with the top layer being rebate of cement without reinforcing steel and plastered and finishing with mortar.

2.3.2 Middle Structure

This temporary house uses a rectangular frame structure of mild steel galvalume C profile. Canal C is arranged is a sloof beam, column, and beam, forming a square frame that is

connected to one another so that the structure functions as a space-forming structure. The system for connecting the frame structure is screwed to the cement rebate floor, there is no excavation of columns or sloof beams, all of which are right above the face of the cement floor. Wall infill is kalsiboard which here only functions as a non-structural partition wall.

2.3.3 Upper Structure

An asymmetrical gable roof. The roof frame, the easel has a shape that adjusts the slope of 60 degrees left and 35 degrees right. The roof truss follows the rules of light steel material so that the structure of the easel is arranged with the concept of a triangular truss with a distance of 1 m. There are 5 horse structures, curtains, and spandex roof coverings. The connection system uses standard mild steel screws.

2.4 Temporary Houses Utilities

2.4.1 Electricity

This temporary house design drawing document does not describe or explain the electrical network.

2.4.2 Sanitary and Plumbing Systems

This temporary house design drawing document does not describe or explain the utility of clean water or dirty water.

3 Conceptual Design

From the explanation above can be illustrated in the Fig. 6.

4 Design Realization

In accordance with the decision of the Lumajang Regional Government as contained in Attachment II to the Regulation of the Lumajang Regent Number 1 of 2022 concerning the Implementation of Temporary Shelter for Victims of Natural Objects of the Mount Semeru Eruption, the technical drawings of the temporary house for victims of the eruption of Mount Semeru are as in Fig. 7. There are several adjustments from the initial design, namely:

4.1 Floor Plan

There is no change in the size of the area on the plan, but the layout of the room is different. The position of the bedroom and bathroom is rotated. Here, it can be seen that the grouping of space zoning is more adjusted based on the level of privacy, where public areas such as multipurpose/living rooms are placed in the front area, then private privacy areas are in the middle and back (bedroom, kitchen, and bathroom).

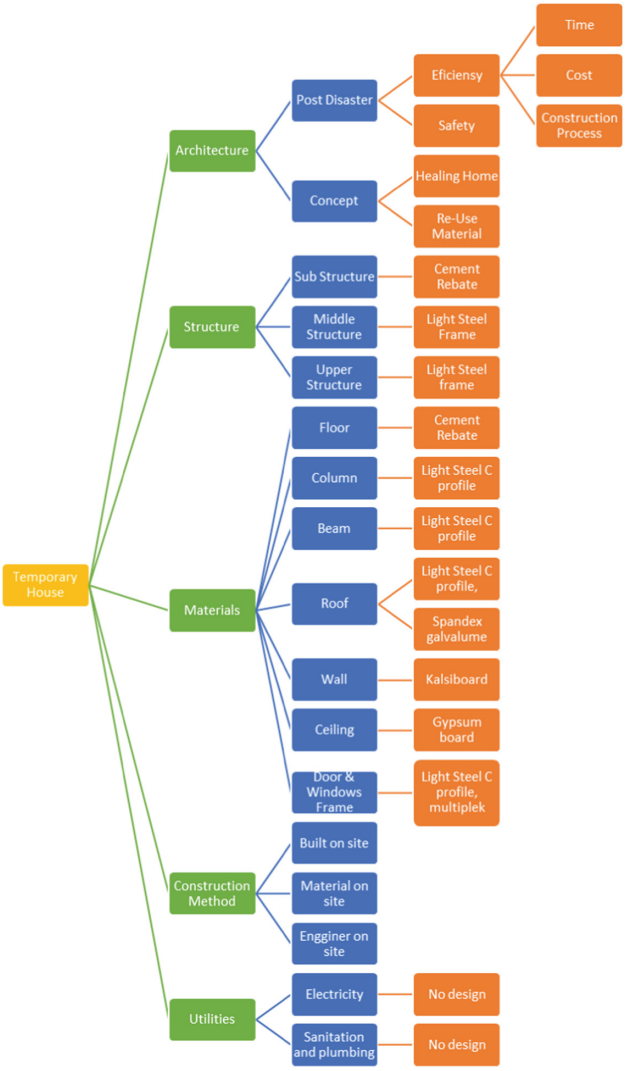

Fig. 6. Temporary Hoese design conceptual chart

4.2 Elevation (Facade)

From the aspect of appearance/elevation there is a change in the shape of the gable roof which was initially not symmetrical to symmetrical which was followed by a change in the structure of the truss structure. Then on the technical drawing of the realization, there is no bouvenlich window for the bathroom.

Fig. 7. Realization of temporary housing designs on site.

4.3 Structure

There are differences in the roof truss structure, which initially used a V galvalum truss structure system to become a conventional truss structure such as a wooden truss. In addition, the structural system has similarities with the initial design.

4.4 Materials

From the material aspect, there is the addition of brick material for the bottom of the wall as high as 60 cm around the length of the wall.

4.5 Electrical Utilities

The technical drawing clearly describes the electrical network in a temporary shelter, consisting of 4 lights, 4 switches, and 2 sockets.

4.6 Sanitary and Plumbing Systems

The technical drawings clearly describe the clean water installation system, namely pipes from the front area, stop faucets in the kitchen area and continuing to stop faucets in the bathroom. For the difference in dirty water, there is a floor drain in the bathroom that

is channeled to the septic tank as well as infiltration which seems to be made of round concrete pipe. The squatting/sitting toilet has not been described. From the explanation above, the following conclusions can be drawn (Table 1 and Fig. 8).

Table 1. Differences in design with the realization of temporary housing development

No.	Aspect	Component	Design	Built	Description
1	Architecture	Post Disaster	✓	✓	no changes
2		"Healing Home & Re-use Materials"	✓	x	Do not apply reuse material
3	Structure	Sub Structure	✓	✓	no changes
4		Middle Structure	✓	✓	no changes
5		Upper Structure	✓	±	no changes
6	Materials	Floor	✓	✓	no changes
7		Column	✓	✓	no changes
8		Beam	✓	✓	no changes
9		Roof	✓	✓	no changes
10		Wall	✓	✓	no changes
11		Ceiling	✓	✓	no changes
12		Door & Windows Frame	✓	✓	no changes
13	Methode	Built on site	✓	✓	no changes
14		Materials on-site	✓	✓	no changes
15		Engineer on-site	✓	✓	no changes
16	Utilities	Electrical	x	✓	there are additional electrical installations
17		Sanitary and Plumbing Systems	x	✓	there are additional plumbing installations

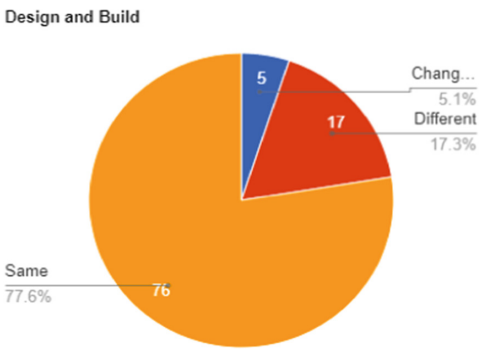

Fig. 8. Percentage of design differences with the realization of temporary housing.

5 Factors of Design Change with Realization

From this study and description of the data sources above, it can be concluded that the change was caused by several factors, namely;

5.1 Site Condition

The condition of the site which was originally a forest area owned by the government was changed to a Temporary Houses relocation area. This is a factor that is quite influencing the design changes that are realized. Especially for the condition of the slope of the soil, the strength of the soil, and its groundwater. In the design, the possibility has not been studied too deeply regarding site conditions, the main focus is only on shelter units based on post-disaster designs, cheap, practical, and fast [7].

5.2 Number of Building Units

In the current relocation area, there are 2,000 units planned to be built. With this number, it is necessary to accelerate considering that the affected victims are still in refugee camps so that the initial design is reviewed and as much as possible is more effective and efficient in terms of time and cost [8].

5.3 Material Availability

In the initial design, it is stated that the materials used also have the concept of re-use materials from buildings that collapsed due to the eruption. However, with a large number of shelters, the material is substituted for materials that are widely available and the supply is quite abundant. So that time efficiency can be achieved. The shape of the roof that is not symmetrical in the design is felt to add quite a long time to create the structural module, so it needs to be modified to be symmetrical and can be mass-produced more quickly and easily. Then add local brick material to increase the strength of the building so that the building is stronger and more durable. Brick is made from local sand which is widely available in the environment, besides that it can also empower the surrounding community [9].

5.4 Human Resources

Apart from community involvement in brick material, many workers and volunteers come from the environment around the relocation site and various regions, so the design that was originally prepared for workers with middle to upper abilities, was changed to be more general and workers and volunteers could participate. build this project [10].

5.5 Government Policy and Common Policy

The design and realization of course cannot be separated from the local government's permission and mutual agreement, as is the case in this shelter, the design is changed and adjusted based on joint considerations and decisions, both from the government, non-governmental organizations (Non-governmental organizations), the community, and affected victims [11].

6 Conclusion

Disaster management must be carried out quickly to reduce the number of victims affected and the losses incurred. Disaster mitigation management needs to be prepared, in this case, a good and appropriate plan for temporary housing for victims affected by the disaster. The resulting design must consider various real aspects that exist in the location, both the user and the environment. Here we need a design module that can generally be used as a basic post-disaster reference, then adapted to the local conditions where the disaster occurred. so the design is not made from scratch and takes a lot of time. as well as the process of adjusting the design to site conditions must also be carried out quickly. From this study, it can be concluded that the disaster management process has been carried out properly, quickly, and precisely, especially for the design of temporary houses. Besides that, it is also supported by a permanent house which was built directly side by side with this temporary house. This temporary house was built by the government, while the temporary house was built by a non-government organization.

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References

1. "[Update] - Hari Kelima Paska Erupsi Semeru, Tim Gabungan Temukan Total 43 Korban Meninggal Dunia - BNPB." https://bnpb.go.id/berita/-update-hari-kelima-paska-erupsi-semeru-tim-gabungan-temukan-total-43-korban-meninggal-dunia (accessed Dec. 18, 2021).
2. "Jembatan Gladak Perak Putus Diterjang Lahar Dingin Semeru | RepJogja." https://repjogja.republika.co.id/berita/r3le03335/jembatan-gladak-perak-putus-diterjang-lahar-dingin-semeru (accessed Dec. 18, 2021).
3. "Pemkab Lumajang Siapkan Huntap dan Huntara Bagi Korban Erupsi Semeru | beritajatim.com," Dec. 18, 2021. https://beritajatim.com/peristiwa/pemkab-lumajang-siapkan-huntap-dan-huntara-bagi-korban-erupsi-semeru/ (accessed Jun. 29, 2022).
4. R. Sushanti, R. Ridha, A. Yuniarman, and A. I. Hamdi, "Strategi Penanggulangan Kerusakan Rumah Tinggal Pasca Bencana Gempa Bumi Di Kawasan Permukiman," p. 8.
5. Allcock, "Healing environments for children who have experienced trauma," *ESSS Outline*, p. undefined-undefined, 2019.
6. K. Sunoko, J. Prijotomo, and V. T. Noerwasito, "Reuse Building Materials Ruins in Post-earthquake Reconstruction Method in Bantul," *Procedia - Social and Behavioral Sciences*, vol. 227, pp. 341–346, 2016, doi: https://doi.org/10.1016/j.sbspro.2016.06.080.
7. G. A. Dy and M. L. P. Naces, "Rebuilding with a heart: architecture roles in post-disaster psychosocial interventions," *Journal of Architecture and Urbanism*, vol. 40, no. 1, Art. no. 1, 2016.
8. D. Chen, G. Wang, and G. Chen, "Lego architecture: Research on a temporary building design method for post-disaster emergency," *Frontiers of Architectural Research*, vol. 10, no. 4, Art. no. 4, 2021, doi: https://doi.org/10.1016/j.foar.2021.08.001.
9. S. Bhattacharjee, S. Roy, and S. D. Bit, "Reliable and Energy-Efficient Post-disaster Opportunistic Network Architecture," *Smart Innovation, Systems and Technologies*, vol. 228, p. undefined-undefined, 2021, doi: https://doi.org/10.1007/978-981-16-1240-4_4.

10. N. O. Nawari and S. Ravindran, "Blockchain and Building Information Modeling (BIM): Review and applications in post-disaster recovery," *Buildings*, vol. 9, no. 6, Art. no. 6, 2019, doi: https://doi.org/10.3390/BUILDINGS9060149.
11. L. Drennan and L. Morrissey, "Resilience policy in practice — Surveying the role of community based organisations in local disaster management," *Local Government Studies*, vol. 45, no. 3, Art. no. 3, 2019.