Transitional House

mediating between the temporary and the permanent

Kelsi Borren

Transitional House: mediating between the temporary and the permanent

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All figures are the author's own, unless otherwise stated

Abstract

The position of architecture in humanitarian relief is limited if it does not adequately meet the needs of people in an appropriate timeframe. Traditionally in the aftermath of a disaster, displaced people are immediately sheltered in community centres or tents, remaining in this state of uncertainty for extended periods of time. Three years after the 2010 Haiti earthquake, over 300,000 people were still living in displacement camps, most of which had no on-site access to water. As the disaster-stricken region sits in a state of disrepair, prefabricated temporary houses emerge months later and continue to be in use for years. Three years on from the 2011 East Japan earthquake and tsunami, over 90,000 people were still living in temporary accommodation. This state of hiatus is typically detrimental to the length of the recovery process – when temporary housing exists for too long, the longevity of the reformation of the city increases. Taking this system failure as a provocation, this research discusses the role of architecture in the immediate reformation of a city. It proposes a transitional house, constructed on site within 24 hours, which can be adapted into a permanent condition within 12 months, as an answer to reforming housing in post-disaster situations. It questions how a change from the traditional response to transitional disaster relief housing can become a feasible option in the aftermath of a disaster, and how such housing can become adaptable for the individual. These ideas are explored through design as research: the problem analysed and revealed through design. The first section reveals the design problem through a literature review, identifying the previous attempts and failures of disaster relief housing. The second section speculates responses for post disaster housing, exploring solutions to the ideas identified in section one. The third section tests the design outcome, refining the design ideas and positioning them within architectural discourse. This thesis explores a departure from conventional New Zealand housing, and the facilitation of a new typology in disaster relief housing.

Acknowledgements

I would like to thank Guy Marriage for the incredible guidance, Allan for all of the technical advice, and Tom for the fantastic editing.

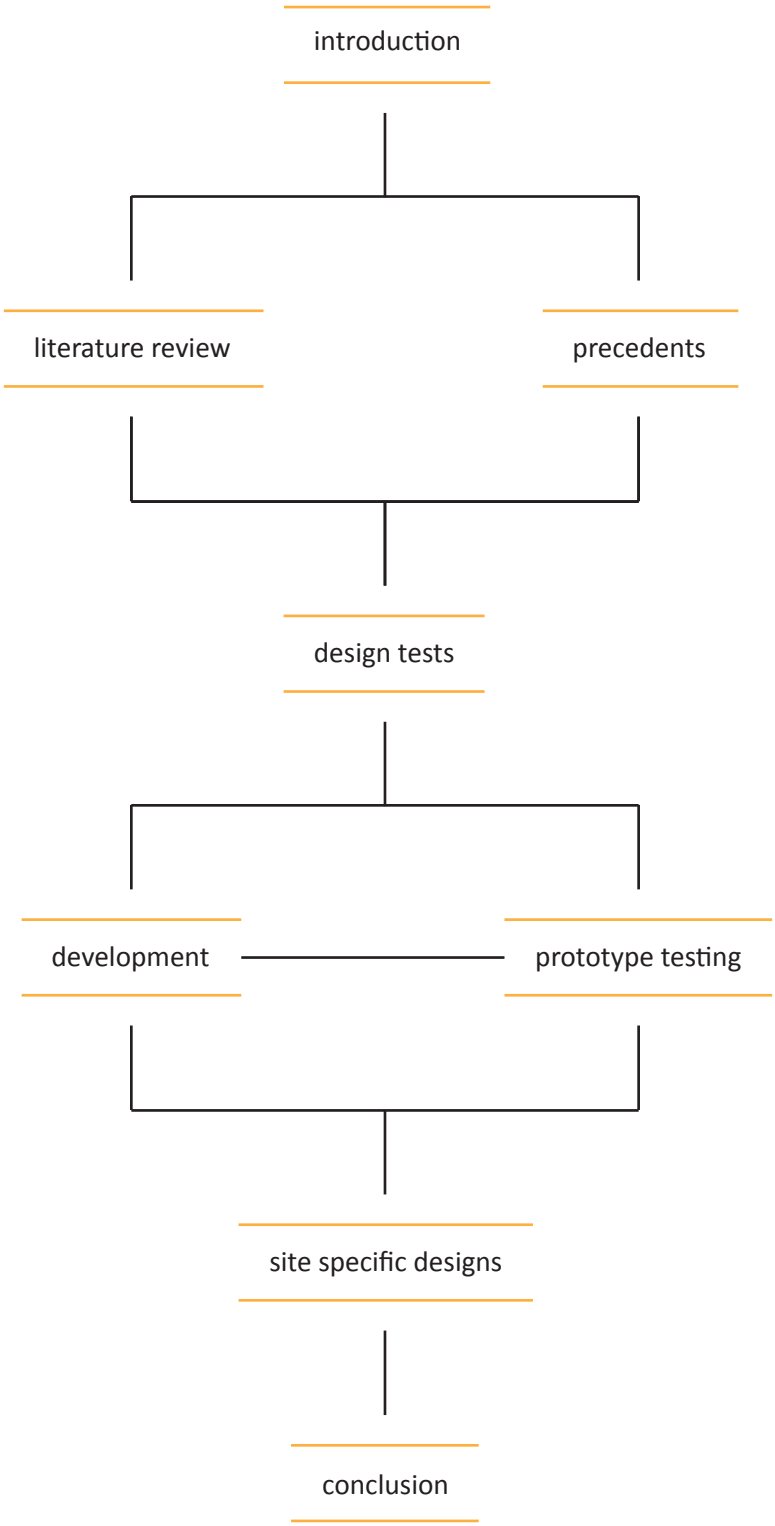

Figure 0.1 Thesis structure diagram

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SECTION ONE:

OBSERVATIONS

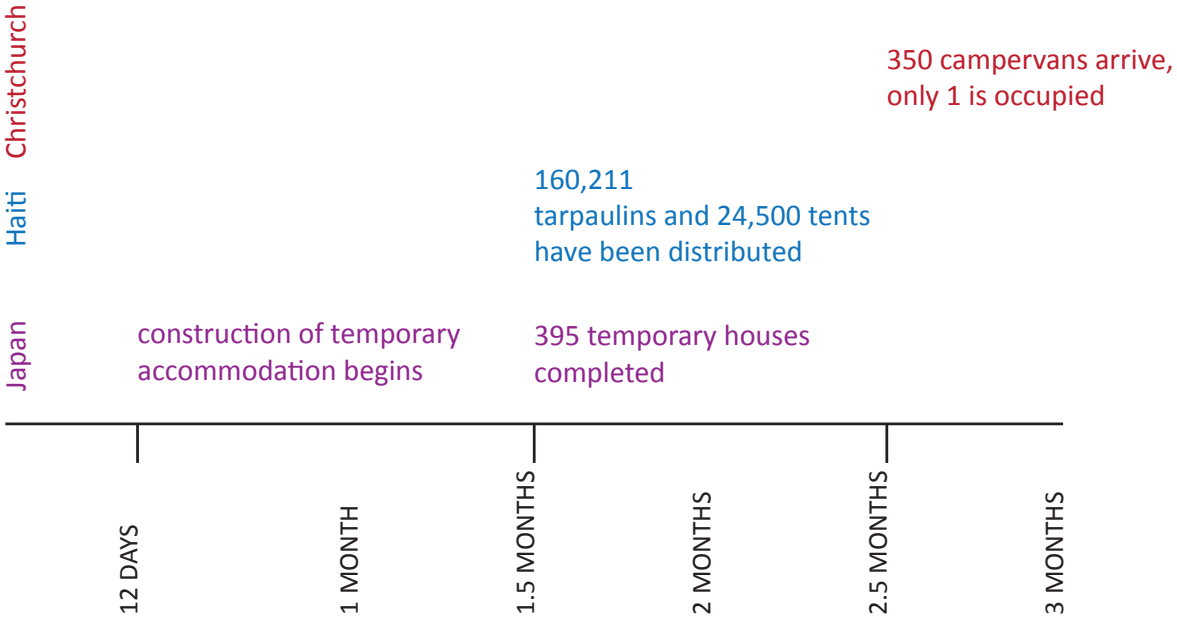


Figure 1.1 Earthquake response timeline in the initial three months following a major earthquake

Introduction / Proposition

The Red Cross estimates that between 2003 and 2012, an average of 106,635 people were killed annually by natural disasters; and on average a further 216,591,900 people were affected every year[1]. The Internal Displacement Monitoring Centre estimates that 32.4 million people were displaced in 2012, due to natural disasters and hazards[2].

As large-scale disasters continue to plague the world, shelter is an immediate necessity for those who have lost their homes. Within three months of the 2010 Haiti earthquake, the Red Cross had spent $43.6 million on shelter including tarpaulins[3]. While immediate shelter can be found in community centres or in tents, these situations cannot exist for too long without taking effect on long term recovery issues. The length of the recovery period is also influenced by the longevity of temporary housing. However, precautions are rarely taken to avoid these situations. After the 2011 Christchurch earthquake, campervans arrived at such a late stage that they were no longer necessary. In contrast, after the 2011 East Japan earthquake and tsunami, the construction of temporary housing had begun within 12 days. The requirement for planned disaster-relief housing is imperative – and obvious.

Experienced and respected architects have devoted time to developing innovative prototypes for disaster relief situations, including Buckminster

1 International Federation of Red Cross, World Disasters Report: Focus on technology and the future of humanitarian action, 2013, accessed March 1 2014, http://www.ifrc.org/PageFiles/134658/WDR%202013%20complete.pdf, 236-238.

2 Internal Displacement Monitoring Centre, Norwegian Refugee Council, Global Estimates 2012: People displaced by disasters, May 2013, accessed March 1 2014, http://reliefweb.int/sites/reliefweb.int/files/resources/global-estimates-2012-may2013.pdf, 6.

3 "Earthquake survivor puts the spotlight on Red Cross' spending in Haiti", Institute for Justice and Democracy in Haiti, accessed March 1 2014, http://www.ijdh.org/2010/04/topics/housing/earthquake-survivor-puts-the-spotlight-on-red-cross-spending-in-haiti/

Fuller, Alvar Aalto, Future Systems, Renzo Piano and Shigeru Ban[4]. Despite the numerous design efforts over the years, little has changed since humanitarian relief originated in the late 1800s[5]. Davis wrote that

> Any consideration of emergency shelter provision following disasters prompts the immediate observation that there must be few subjects in the whole field of building on which so much effort has been expended, so much money spent, and yet, paradoxically, where so little is really known.[6]

This thesis investigates how architecture can aid in the immediate and ongoing reformation of housing. The research extends on current architectural discourse about the requirements of disaster relief housing and reveals an adaptable transitional house as an answer to the design problem. The speculative transitional house is explored through various ideas and critically reflected upon against the design objectives. Its implications are then exposed as it is positioned within specific conditions in Wellington. This thesis provides insight into emergency housing typologies, and proposes to formulate a new typology which can be used primarily in New Zealand but also in other contexts across the globe.

4 R H Kronenburg, "Mobile and Flexible Architecture: solutions for shelter and rebuilding in post-flood disaster situations", (paper presented at the Blue in Architecture09 Symposium, September 24-27 2009), 2.

5 Architecture for Humanity, *Design like you give a damn: Architectural responses to humanitarian crises* (New York: Metropolis Books, 2006), 35.

6 Ian Davis, *Shelter after disaster* (Oxford: Oxford Polytechnic Press, 1978), xv.

Research problem

Research question

This thesis sets out to consider the transitional house as a tool to re-evaluate post-disaster responses. It asks –

How can transitional disaster relief housing become adaptable for the individual?

In relation to this question, objectives were formulated:

To explore how a temporary shelter can transition into a permanent dwelling

To utilise modern fabrication techniques to aid in the efficiency of the construction on site

To explore what pack-down techniques can offer in terms of storage and transportation of the components

To offer a simple and cost-effective solution to housing through the use of prefabrication methods

To facilitate the siting of post-disaster shelters on people's own land if possible, or in their wider communities

To allow for easy adaptation in order to suit individual needs.

This thesis aims to extend the ideas of post-disaster housing in architectural discourse and to critically explore the implications and limitations of the design.

Scope

This research addresses domestic conditions after a natural disaster. The impact on domestic architecture varies from complete destruction, to the partial failure of single components within a house. This research has a number of implications for post-disaster situations but is limited to the scope of a Masters design-as-research thesis. Therefore, the main component of the research lies in the initial response shelter for those who are unable to continue living in their homes. It assumes the eventual demolition of an existing damaged house, and the requirement of a completely new dwelling. If individuals' own land is unable to be used for shelter due to the effects of the natural disaster, a community space is occupied instead.

The initial shelter is explored in depth. The transitional aspect of the design into a state of permanence is explored diagrammatically through design, to communicate the ideas of adaptation, choice and variability.

Methodology

The idea of design as a form of research has been a prevalent topic in recent architectural discourse. Groat and Wang hold the position that "design, as such, is not research, as such" but that research can aid the design process, and that design and research are equal in intellectual significance[7]. However Crouch and Pearce, as well as Downton, propose that design itself is research. Downton argues that "design processes both use knowledge and also produce personal knowing and collective knowledge"[8] (refer figure 1.2).

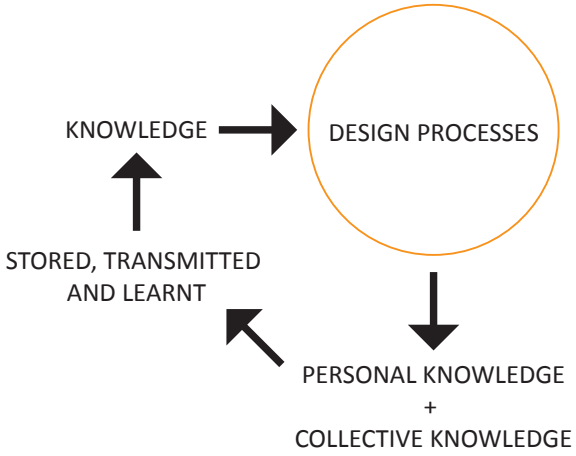


Figure 1.2 Methodology diagram

Crouch and Pearce state that four distinct methodologies exist within design as research: ethnography, narrative, case study and action research[9]. This thesis follows the path of action research – the research is in a constant flux of observing, reflecting, planning and acting (refer figure 1.3).

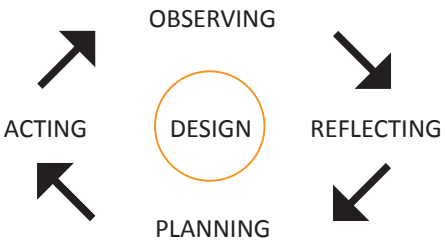


Figure 1.3 Action research diagram

This thesis holds the position of design as research. The literature review aids the realisation of the design problem by revealing the failures of previously attempted post-disaster housing. However, the bulk of the research in this thesis is embedded within the design itself – including the design processes, the design outcome, and the critical design reflections.

7 Linda Groat and David Wang, *Architectural Research Methods* (New York: Wiley, 2001), 102.
8 Peter Downton, *Design Research* (Melbourne: RMIT Publishing, 2003), 55.
9 Christopher Crouch and Jane Pearce, *Doing Research in Design* (London: Berg, 2012), 62-63.

Methods

This research was formed using mixed-method approaches. Mixed-method design approaches are frequently used in the design field, without explicitly thinking of these approaches as research[10]. In particular, this thesis works with both digital modelling and physical modelling – known as digital craft. Stacey's notion of digital craft is the repeated interaction between digital modelling and physical modelling to create prototypes for the testing of design ideas, where the use of prototyping as a feedback loop ensures the optimisation of the design outcome[11]. The degrees to which a designer might move between digital and physical vary. Downton questions the relationship between digital and analogue, asking:

> Does reading a digital representation require, or produce, different and useful kinds of knowledge compared to a direct, unmediated reading of an analogue original, or do representations of analogue phenomena via digital media distort and debase our knowledge of the original?[12]

This thesis holds the position that while the digital and physical can co-exist in a manner conducive to a fully realised design, one should not take the place of the other.

Design process section: part one uses the method of digital modelling, with the programmes *rhino* and *grasshopper*. It then explores the translation from digital to physical, with small scale physical model tests.

Part two and part three primarily use digital modelling.

Part four uses physical modelling as a tool to generate forms, followed by sketching and digital modelling to develop the design. Physical modelling is then used again to explore the limitations of the design.

Sketching then rapidly explores formal options, and digital modelling is used to develop the final design. Rapid physical modelling investigates the ideas, before a large scale 1:10 model rigorously tests the design. From this point, sketching and digital modelling develop the design, and are then used to test the design on multiple sites.

10 Groat and Wang, *Architectural Research*, 124.

11 Michael Stacey, "Digital Craft in the Making of Architecture", in *Manufacturing the Bespoke*, ed. Bob Sheil (Chichester: John Wiley and Sons, 1998), 68.

12 Downton, *Design Research*, 66.

Literature review

This literature review is in two parts: first, it expands on the need for a change in thinking with post-disaster architecture; and second, it explores how adaptation and prefabrication can aid in post-disaster housing.

The first part establishes the necessity in changing the architecture of post-disaster housing. It discusses how conceptions of humanitarian relief housing have endured through to this day and the detrimental effects these have. This research argues that architecture must depart from the conventional responses and establish a new typology in disaster relief housing.

The second part explores how adaptation and prefabrication techniques can be incorporated into architecture. In a post-disaster situation, both of these approaches offer a set of strategies to assist in the radical change necessary in housing responses.

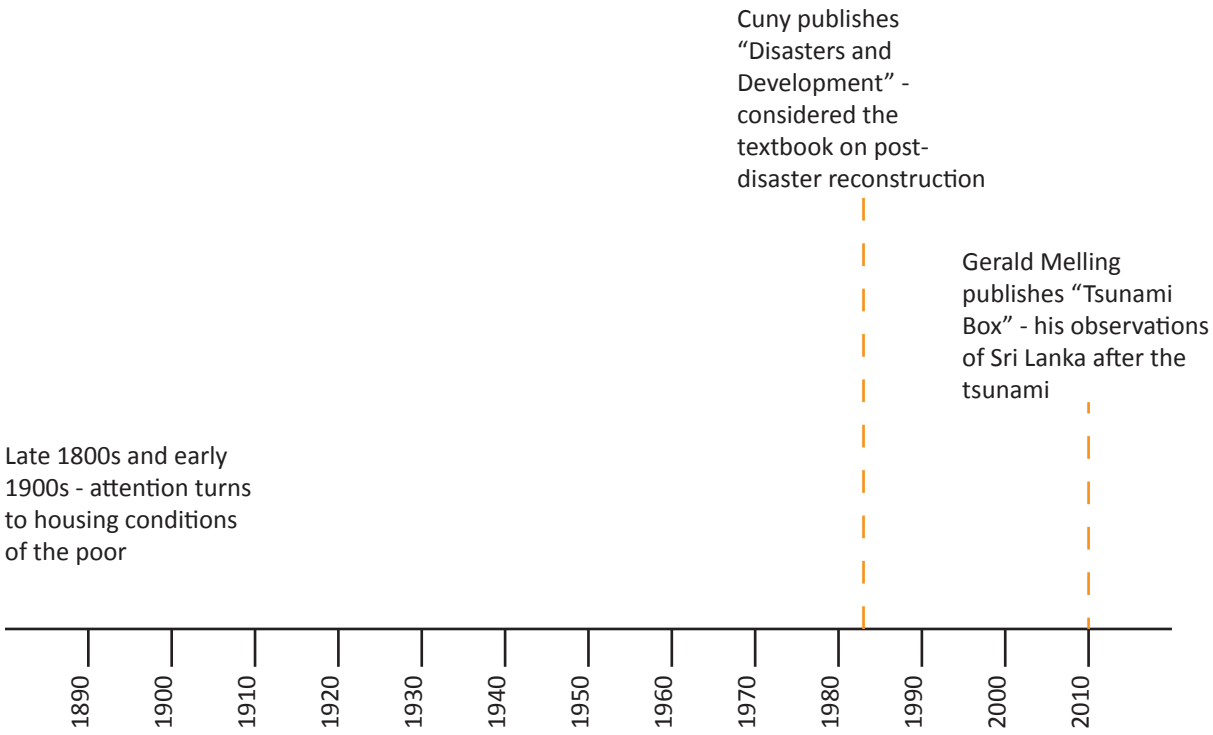


Figure 1.4 History timeline - part one

Part one

The origins of humanitarian design can be traced at least as far back as the late 1800s, but the same issues exist today[13]. Five of these issues are commonly found in architectural discourse and will be addressed in this literature review. First, that international humanitarian aid often provides insensitive solutions which are not in the interests of the local people. The second is the failure to adequately prepare for disasters. The third is that temporary emergency shelters are not adequate for a number of reasons, and have bad implications for reconstruction. The fourth is that the relocation of earthquake victims has negative effects for both reconstruction and psychological well-being. Lastly, that change is slow in coming in post-disaster relief due to the failure to learn from previous attempts.

Issues of context

> ***The role of an architecture – if there is one – in a fractured world of life-changing trauma is to support the recovery of a broken spirit, not lazily amputate in favour of prosthetics.[14]***

Melling explains that incompetence and alleged corruption in aid programmes are commonly discussed but that "the manipulative power and excessive demands of sponsors" are less well known[15]. Following the 2010 Haiti earthquake, most international humanitarian agencies stayed in Haiti for at least twelve months. While international aid is appreciated in these situations, it can fail to meet the needs of the people themselves. The disaster-stricken region often merely needs assistance in its recovery, rather than the imposition of international agencies' methods. Cuny explains that any international response to a disaster is a form of intervention, and that "the failure to treat it as such is one of the underlying causes of many of the problems relief agencies encounter"[16]. He goes on to explain that international aid has the potential to be helpful but that its benefit will be limited until it is provided in a culturally-sensitive manner[17]. Often, the distances and communication difficulties can result in the inability to overcome cultural obstacles, which hinder the effectiveness of disaster relief responses. Cuny writes that the largest issue for any intervener is how to identify the coping mechanisms that already exist, and how to relate outside help in order to work alongside the local disaster response systems[18]. Cuny writes that a tool for effectiveness in a foreign culture is that:

> choices must be made at the field level,

13 Architecture for Humanity, *Design: Architectural responses*, 35.
14 Gerald Melling, *Tsunami Box* (Wellington: Freerange Press, 2010), 13-14.
15 Ibid, 27.
16 Frederick C. Cuny, *Disasters and Development* (New York: Oxford University Press, 1983), 7.
17 Ibid, 86.
18 Ibid, 90.

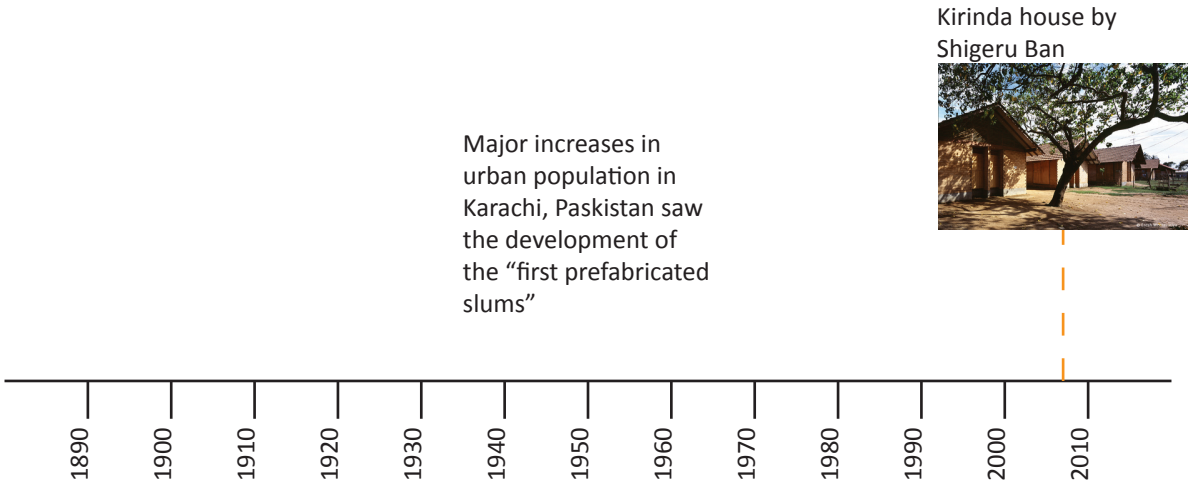


Figure 1.5 History timeline - part two

> and the people making these choices need a supportive, not restrictive, framework of rules, procedures, and policies to assist in this process[19].

If disaster relief responses are enforced rather than adapted to its context, they will be inappropriate.

Iftekhar Ahmed writes that the issue of inappropriate relief for the cultural context is common:

> An extensively observed inadequacy of reconstructed housing in many developing countries in a variety of contexts is its cultural inappropriateness resulting from the lack of understanding of local needs by implementing agencies. The inappropriateness is evident in size and style of houses, design of spaces within and around the house, choice of building materials and infrastructural services[20].

This is likely due to the top-down approach adopted in the rush to respond to disasters, with local analysis, perspectives, skills and vital information held by the local people and organisations going to waste, and a "one size fits all" model used instead[21].

Inappropriate housing is either unused, or adapted to such a degree that there was no point in them to start with. Charles Abrams writes that aluminium prefabricated dwellings in Karachi, Pakistan, were adapted by the owners with the local materials of adobe and discarded wood, along with other makeshift building components, making them "the first prefabricated slums"[22]. Melling explains, from his experience in Sri Lanka, that inappropriate housing creates issues:

> For refugees from the modest villas and hand-hewn shacks of beach communities, high-density, high-rise apartments invite serious social unrest. Similarly, the middle-class gestures of suburban maisonettes huddled together on the outskirts of towns turn the very idea of tsunami re-settlement into a Bollywood joke opera. And – in an isolated but startling paradox – the well-crafted, excessively expensive 'tourist' chalets designed by the celebrated Japanese architect Shigeru Ban for the Muslim families of Kirinda (here distracted by his own exalted reputation), appear blissfully unaware of the cultural and climatic subtleties of siting, internal

19 Cuny, *Disasters and Development*, 125.

20 Iftekhar Ahmed, "An overview of post-disaster permanent housing reconstruction in developing countries", *International Journal of Disaster Resilience in the Built Environment* 2:2 (2011): 152.

21 Joanna Hoare, Ines Smyth and Caroline Sweetman, "Introduction: post-disaster humanitarian work", *Gender and Development* 20:2 (2012): 215.

22 Charles Abrams, *Man's Struggle for Shelter in an Urbanizing World* (Cambridge: MIT Press, 1964), 166.

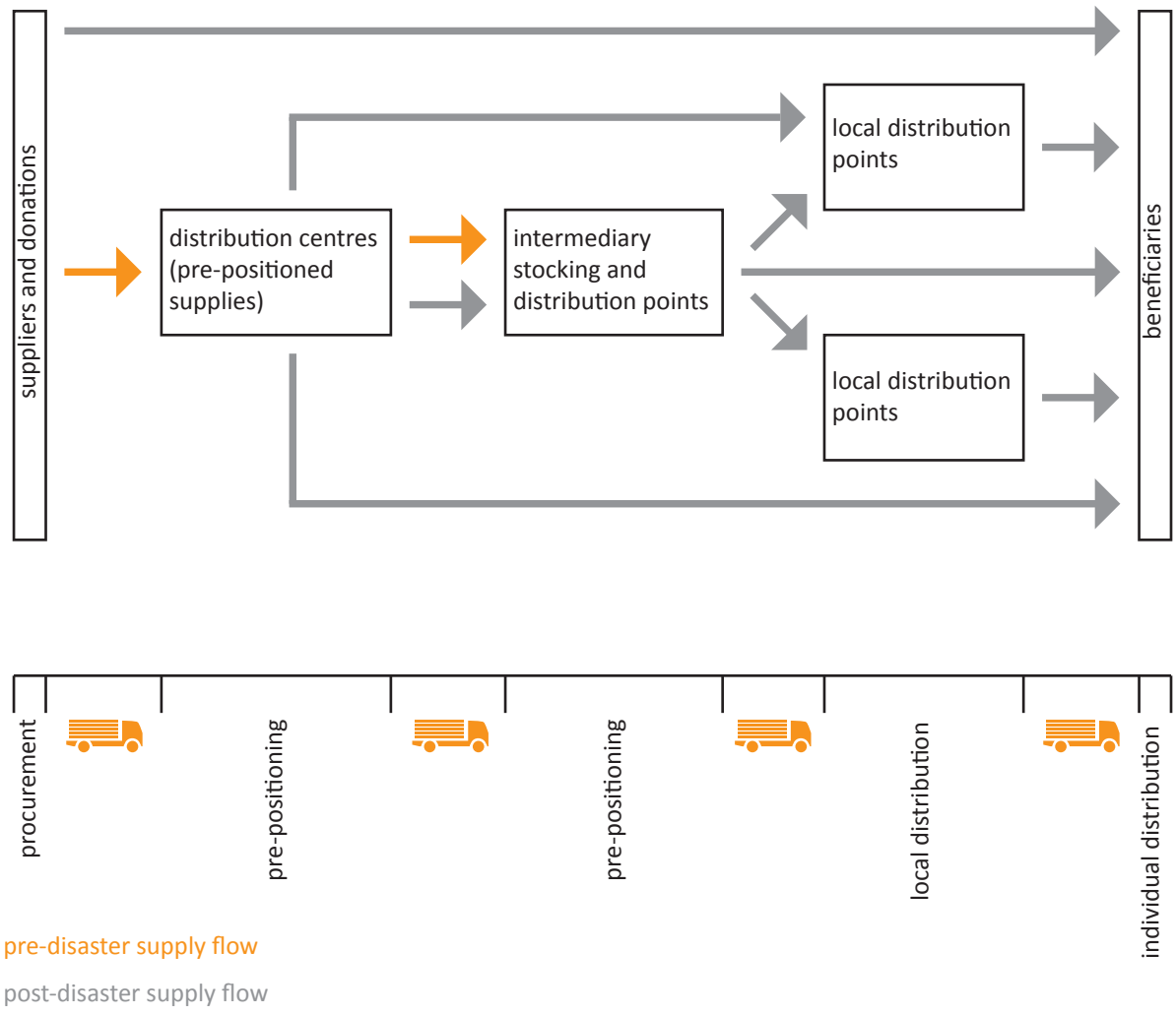


Figure 1.6 Supply of relief items - the pre-disaster supply flow is simple, limiting the variations of transport flows and the difficulties these impose. The use of distribution centres also ensures that there is no unnecessary duplication in aid efforts.

> planning and appropriate use of materials[23].

Ian Davis claims that there are three basic forms of international response: the first is to ignore or deliberately attempt to modify the cultural habitats of the occupants, the second is to produce universal solutions assuming that living patterns are similar throughout the world, and the third is to recognise cultural issues and try to modify traditional housing techniques in order to produce a safer environment[24]. The first two forms of response are clearly inappropriate, as described by Ahmed, Hoare, Abrams and Melling. However, in the case of immediate international aid, the third response is unfeasible if each country does not have its own prepared response.

Understanding that sensitive design is difficult to achieve highlights the challenge of designing for different contexts in post-disaster situations. The transitional house proposes to avoid this insensitive and inappropriate approach by designing specifically for a New Zealand context. Numerous cultural and contextual challenges lie within New Zealand itself. The transitional house could then be adapted to meet the needs of international users.

23 Melling, *Tsunami Box*, 27.
24 Davis, *Shelter after disaster*, 17-19.

Preparedness

> ***Together, the storms served as a stark reminder of the need to plan for regional emergency shelter before – not after – the inevitable happens.[25]***

While personal preparedness is constantly reiterated to citizens, governments often neglect to prepare responses to shelter in an appropriate way. Shughart writes that the public sector fails in supplying disaster relief in socially optimal quantities, and that:

> because it facilitates corruption, creates incentives for populating disaster-prone areas, and crowds out self-help and other local means of coping with disaster, government provision of assistance to disaster's victims actually threatens to make matters worse[26].

Balcik et al explain that relief organisations that purchase supplies in advance pre-position these strategically at distribution centres or at multiple intermediary levels (see figure 1.6), but that:

> due to the uncertainty of disaster occurrences, funding tendencies in the

25 Architecture for Humanity, *Design: Architectural responses*, 30.
26 William F Shughart, "Disaster Relief as Bad Public Policy", *The Independent Review* 15:4 (2011): 520.

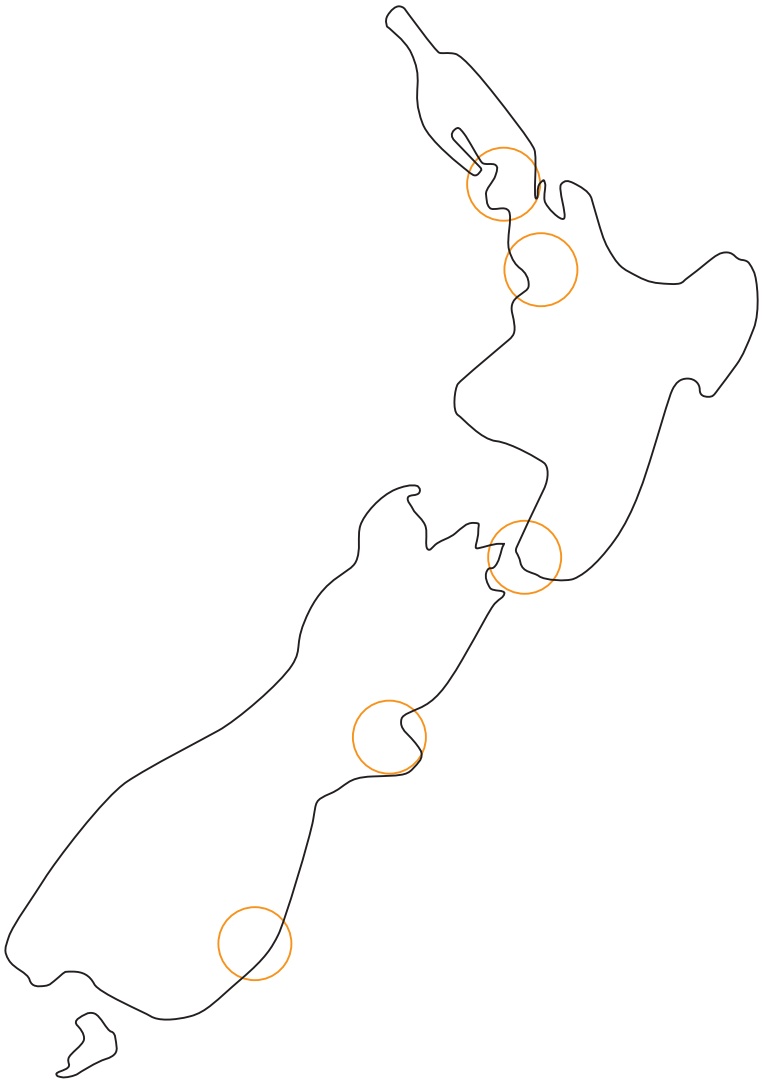


Figure 1.7 Possible locations of distribution centres in New Zealand. The transitional houses can then be transported from these points.

> sector, and the costs associated with operating distribution centres, only a few relief organizations use this strategy[27].

Due to these cost issues, some organisations may establish distribution centres temporarily to support disaster relief logistics if it is not feasible to pre-position the supplies - airports and seaports are commonly used for this purpose[28]. If costs are the primary consideration before a disaster, then governments will continue to neglect in planning for post-disaster shelters. However, long-term costs can be reduced with well-planned disaster housing, and so this thesis will assume that the storage of shelter is financially possible and appropriate.

Chang et al note that:

> The shortage of aggregate, human resources, and heavy equipment has been identified as one of the potential constraints to the recovery process in New Zealand if a large-scale disaster strikes[29].

Resourcing-related problems impacting effectiveness of recovery in other countries include: ineffective resourcing approaches, poor resource management, speculating the procurement of materials, and environmental concerns induced by intensified logging and mining activities[30].

Shelter responses in the event of a disaster must be considered and planned prior to the occurrence of the disaster. If the shelter is to be provided immediately, it needs to be held in storage - otherwise its arrival will be too late. The cost issues involved in storage can be remedied by providing a solution which can pack down into a smaller size for storage and transportation.

This research proves that adequate preparation is necessary before disasters occur, but also highlights particular issues for New Zealand - including the shortage of skilled people and necessary construction equipment. The transitional house therefore, by necessity, must be able to be built without heavy machinery and by untrained people. The use of modern fabrication techniques will simplify the construction process, so that untrained people can construct it themselves.

27 Burcu Balcik et al, "Coordination in humanitarian relief chains: Practices, challenges and opportunities", *Int. J. Production Economics* 126 (2009): 24.

28 Ibid.

29 Yan Chang, Suzanne Wilkinson, Erica Seville, Regan Potangaroa, "Resourcing for a resilient post-disaster reconstruction environment", *International Journal of Disaster Resilience in the Built Environment* 1:1 (2010): 66.

30 Ibid.

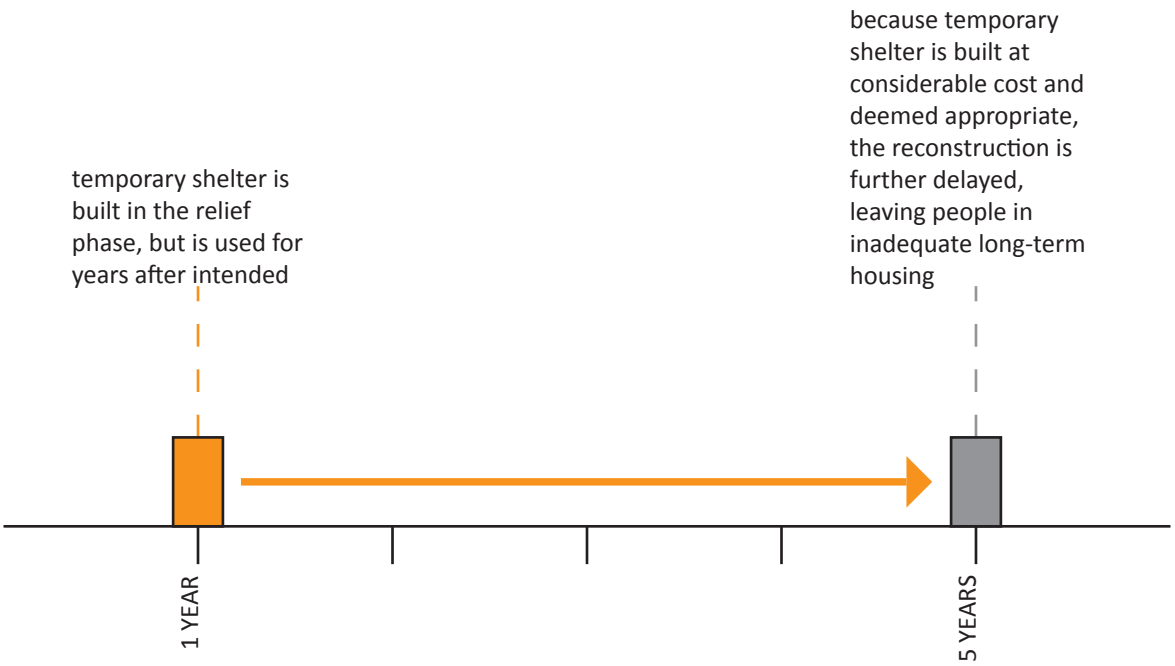


Figure 1.8 Temporary housing is ineffective for long-term housing

Implications of time

> ***Emergency shelter is rarely needed, even after earthquakes. People can build adequate emergency shelter from the rubble and usually do so long before emergency shelters or tents arrive.[31]***

Kronenburg writes that emergency shelter can prevent further distress, illness and death if it is made available, and therefore "must be in use by the victims within the first few days of the post-disaster situation if it is to be at all effective"[32]. UNHCR tents are often used in refugee situations, but there has been a growing sense within the agency that the design of the standard family tent should be overhauled[33]. The canvas tents are heavy, difficult to transport, costly to ship, and are unable to be stored for long periods due to the deterioration of canvas over time[34]. However, Stohr claims that other systems over the UNHCR tents have yet proven to be effective, with several problems commonly occurring:

1) Failure due to the time for the systems to arrive on site, with other shelter arrangements already having been made in the meantime

2) Failure due to the shelter being perceived as "too permanent" in host locations, creating less incentives to return home

3) Failure due to difficulty or cost in replication[35].

Emergency shelter itself is ineffective due to displaced people living in transition for several years in the shelters intended to be temporary[36]. Several authors discuss the need for something beyond temporary architecture. Elisabeth Babister observes that

> Emergency shelter is temporary and is intended just to provide shelter for survival. Transitional implies something that is longer-term and gives you space to carry out livelihood activities rather than just surviving[37].

Transitional, rather than temporary, architecture removes the stigma of response phases. Ian Davis notes that he avoids the time phase called the relief period, as

> Any study of these topics rapidly shows that relief, rehabilitation and reconstruction, though definite phases,

31 Cuny, *Disasters and Development*, 60.
32 Kronenburg, "Mobile and Flexible Architecture", 5.
33 Architecture for Humanity, *Design: Architectural responses*, 60.
34 Ibid.
35 Ibid.
36 Architecture for Humanity, *Design like you give a damn (2) Building Change from the ground up* (New York: Abrams, 2012) 84.
37 Architecture for Humanity, *Design: Architectural responses*, 99.

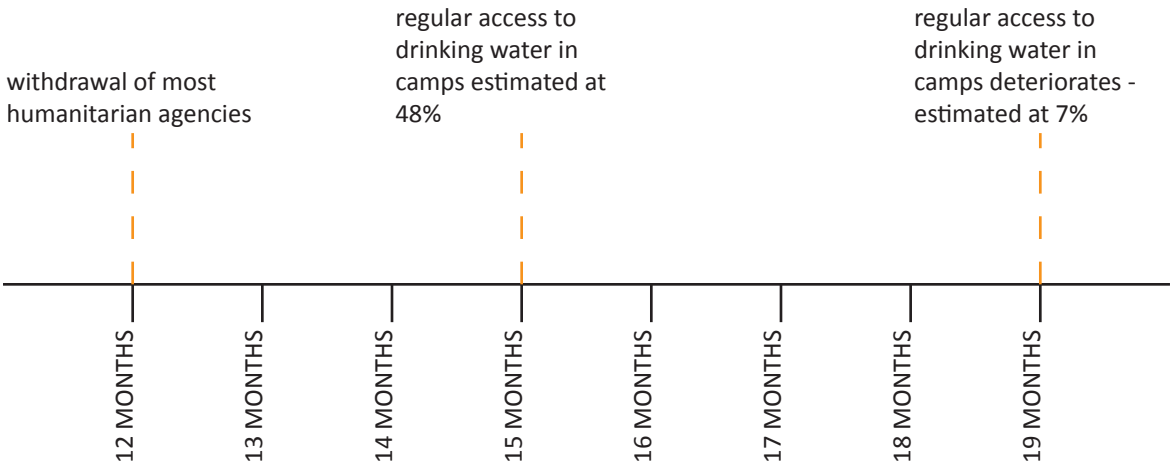


Figure 1.9 Effect of withdrawal of relief workers after the 2010 Haiti earthquake

> constantly overlap, and the immediate decisions made within days of a disaster have a habit of influencing long-term events[38].

Cuny also argues that phases should not be defined, especially as relief workers see themselves limited to the emergency phase which results in two issues:

> First, the agency expands its definition of the emergency period to span several months; it then delivers emergency equipment and resources long after the actual emergency needs have passed. Second, the agency tends to push its employees and counterparts to develop programs and have them completed, or at least have resources committed, before the end of the arbitrary emergency period. As a result, the local staff is forced to rush into a confused and disorganised situation, gather information that may not be accurate, and develop programs that either ignore the local coping mechanisms or take key leaders away from other activities more appropriate for the time period. The usual results are programs that are poorly conceived and executed[39].

Mulligan and Nadarajah also state that timeframes cannot be put on the process for moving from relief to long-term recovery:

> International aid agencies either need to adopt more open-ended commitments for working on long-term social recovery or they need to undertake serious transition planning to make sure that local organizations are able to take over this work when they leave[40].

After the withdrawal of humanitarian agencies following the 2010 Haiti earthquake, regular access to drinking water in displacement camps dropped from 48 per cent to only 7 per cent (refer figure 1.9). This is due to the failure to ensure that processes are in place for long-term recovery.

Kronenburg writes that emergency relief should be focused on providing shelter within existing communities to support local rebuilding, and needs to be applied quickly and as close to the centre of need as possible[41].

> The shelter should be capable of supporting the efforts of the victims to rebuild their lives, economic activities and community, so its deployment should not divert resources from these activities. It should therefore be capable of erection speedily with the minimum of effort, and fulfil its function for the duration

38 Davis, *Shelter after disaster*, xv.

39 Cuny, *Disasters and Development*, 42-44.

40 Martin Mulligan and Yaso Nadarajah, "Rebuilding community in the wake of disaster: lessons from the recovery from the 2004 tsunami in Sri Lanka and India", *Community Development Journal* 47:3 (2011): 366.

41 Kronenburg, "Mobile and Flexible Architecture", 5.

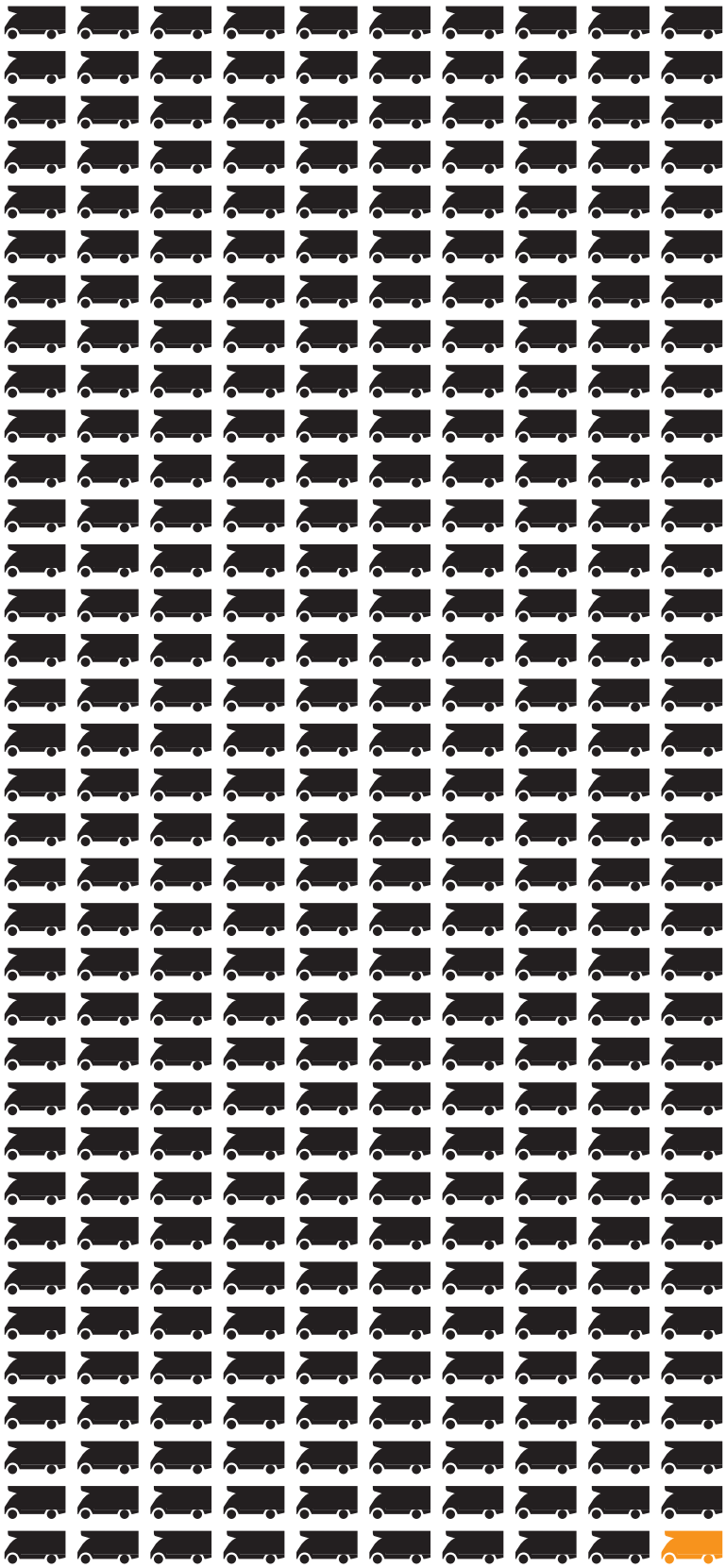


Figure 1.10 Only 1 campervan is occupied at the A&P showgrounds after the Christchurch earthquake.

> of the emergency period without further maintenance…. Any permanent components in the shelter's construction should be capable of recycling into permanent building stock[42].

Stohr claims that this is an important strategy for quick reconstruction. Building transitional housing using materials that can be reused in the construction of permanent housing achieves two goals:

> First, it allows humanitarian aid agencies to provide shelter on temporary sites rather than waiting for land-use issues to be resolved. Second, it can help defray families' construction costs for building permanent housing by giving them materials that they can later sell or repurpose[43].

This form of transitional shelter can bridge the gap between relief work and future development, and remedy the previous issues found in temporary shelter[44].

The implications of time in post-disaster situations are huge, as the appropriateness of post-disaster housing relies on time. The challenge therefore lies in meeting particular requirements in the relevant timeframe. The transitional house seeks to engage with this issue through a proposed timeline.

42 Kronenburg, "Mobile and Flexible Architecture", 5.
43 Architecture for Humanity, *Design: Architectural responses*, 98.
44 Ibid, 302.

Disadvantages of relocation

> ***Relocated earthquake victims often show considerably greater long-term stress than those who remain in the devastated area.[45]***

Rafieian and Asgary discuss the impacts that different forms of temporary housing have on the reconstruction process. Studies show that temporary housing erected on owner's own sites have more advantages over temporary housing on campsites[46]. They write that evidence suggests that people living on site have a better reconstruction experience, and earn higher satisfaction[47], whereas those who live in campsites perceived negative impacts on the reconstruction efforts[48]. Rafieian and Asgary also noted that after the 2003 earthquake in Bam and Baravat in Iran, the government had difficulty filling the temporary houses located in campsites, as people were reluctant to relocate to campsites that were too remote from the city centre or their neighbourhoods[49]. The same issue has been found

45 Giovanna Caia, Fabrizio Ventimiglia, Anne Maass, "Container vs Dacha: the psychological effects of temporary housing characteristics on earthquake survivors", *Journal of Environmental Psychology* 30:1 (2010): 61.
46 Mojtaba Rafieian and Ali Asgary, "Impacts of temporary housing on housing reconstruction after the Bam earthquake", *Disaster Prevention and Management: An International Journal* 22:1 (2013): 63.
47 Ibid, 66.
48 Ibid, 71.
49 Ibid, 65.

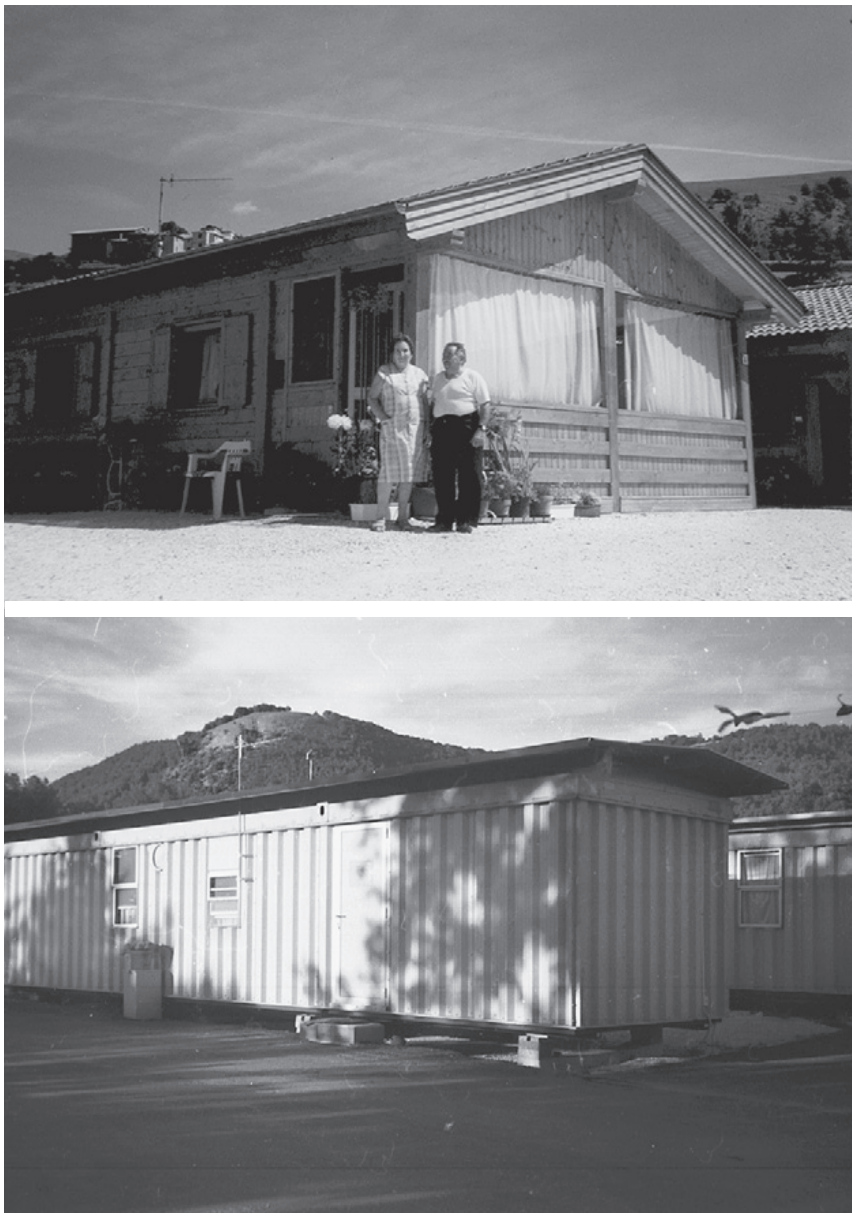


Figure 1.11 The vernacular vs container temporary housing used after the 1997 earthquake in central Italy. Source: Caia, “Container vs Dacha”, 61-62.

in New Zealand, where the government provided over 350 campervans after the Christchurch earthquake, and only one was occupied (refer figure 1.10). While no study has been conducted for this specific situation, it could be assumed that this is also due to reluctance to relocate (as well as timeliness and typology of housing).

Caia, Ventimiglia and Maass claim that post-traumatic stress is linked to the interruption of normal life that is associated with being relocated to a different area or living in temporary housing that is below normal standards of living[50]. They write that relocated earthquake victims "often show considerably greater long-term stress than those who remain in the devastated area"[51]. In a study they found that earthquake survivors were more satisfied with temporary housing which resembled a home than with unfamiliar shipping container housing, and that surprisingly they were no less satisfied than people who continued to live in their own permanent homes[52]. Those who lived in temporary houses resembling a home showed fewer psychological stress symptoms, less discomfort and a lesser feeling of being dominated by the situation than the container inhabitants[53]. Consequently, the study suggests that the attitude towards different types of temporary housing plays a role in stress-reduction.

These studies show that the siting of a transitional house on the victims' own land where possible, rather than in campsites, has a positive effect for both long-term reconstruction efforts and personal well-being. A transitional house which holds a resemblance to typical housing, will also increase well-being – and be less likely to meet a cultural resistance.

Failure to learn

> ***Prototypes for "instant housing" that had failed in one disaster would reappear in slightly altered form in the context of another.[54]***

Cuny explained in 1983 that change had been slow in coming to the relief system for many reasons, with the nature of the system and the way it is organised as the primary obstacle[55]. He observes that contributing factors include the following:

1) Lack of collective memory:
Relief organisations are often slow to change because they have not internalised lessons learned in the field

50 Caia, "Container vs Dacha", 61.
51 Ibid.
52 Ibid, 65.
53 Ibid, 60.
54 Architecture for Humanity, *Design: Architectural responses*, 46.
55 Cuny, *Disasters and Development*, 132.

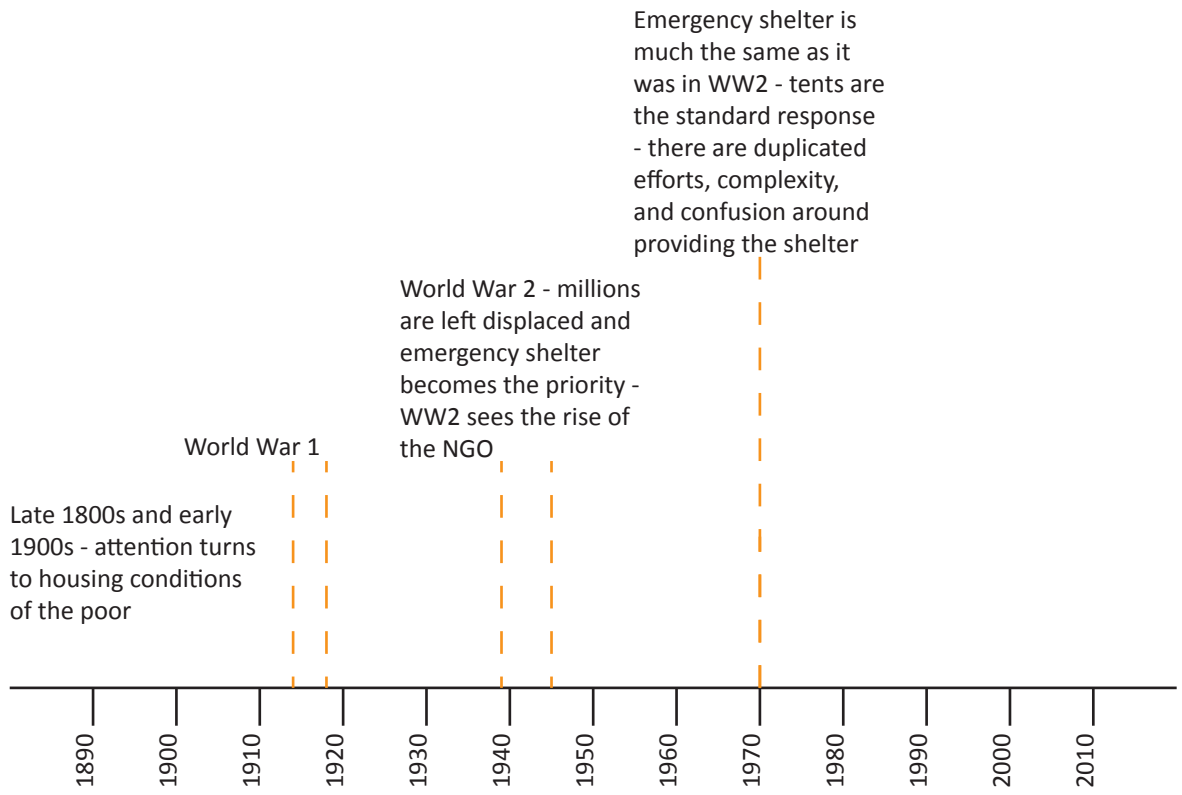


Figure 1.12 History timeline - part three

2) Failure to evaluate disaster programs:
Evaluations are not a priority activity

3) Failure to apply research:
Research in the disaster field is segmented, with concentration of the technical and, to some degree, the behavioural aspects. It is also difficult to translate the results into useful applications

4) Reliance on volunteers:
Volunteers who have no prior training and little information about the society or the role of volunteers in disasters, need to be balanced with trained professional staff

5) Lack of training:
The amount of time spent on disaster-orientation in staff training programs is usually minimal[56]

Disaster relief responses require a radical change in order to deviate from the traditional inadequate approaches. Realising that the failures of previous attempts must be understood and learnt from, this research seeks to challenge what has not worked and to propose a way forward. The reluctance to change is caused by the lack of desire to point fingers at previous failures, which is often thought of as personal. The failures of post-disaster housing attempts have therefore been addressed through this literature review, in order to offer potential answers for transitional housing schemes.

56 Cuny, *Disasters and Development*, 132-136.

The first part of this literature review has explored the existing issues in humanitarian relief, and the need for change. It has revealed the need for a new typology, which can appropriately meet the requirements of post disaster housing. Detrimental issues include: international aid provides insensitive solutions that are not in the interests of local people; a failure in adequately preparing for disasters exists; temporary emergency shelters are not adequate and have poor implications for reconstruction; relocation has bad effects for reconstruction and for victims well-being; and that change is slow in post-disaster relief due to the failure to learn from previous attempts. The second part of this literature review will look at tools to assist in the creation of a new typology.

Part two

Designing for adaptation and prefabrication has been evident in architecture for a long time. However, the potential for these to become fully realised in post-disaster housing is huge. Both adaptability and prefabrication are discussed in this literature review and explored in terms of their scope in disaster relief housing.

Adaptable housing

> ***Residences can be designed and constructed to become life-cycle houses where changes are achievable and ongoing.***[57]

After a disaster resources may be difficult to come by and unsustainable methods are often used. Adaptability can ensure that disaster-relief housing is sustainable long term.

> In principle, a building that can last while its parts gradually change will place a lighter load on natural and human resources and provide value to future generations[58].

If components that change over time are designed for assembly, disassembly and reuse or recycling, this is another benefit for a sustainable future[59].

Friedman proposes that adaptable housing in general is becoming more relevant with "demographic diversity and the rise in the number of non-traditional households", in addition to the continuing introduction of new technologies which, paired with excessive consumption, require people to continuously upgrade their domestic systems[60]. Friedman writes that the starting point for adaptable housing was 1927, with Mies van der Rohe's steel frame house built for the Stuttgart Exhibition, in which the interior walls could be relocated[61].

However, Arge writes that adaptability started with the period of architectural structuralism in the 1970s, when three concepts of adaptability were developed: generality, flexibility, and elasticity[62]. Generality is the design of a building for multifunctional use; flexibility is the built-in possibilities to rearrange, take away or add elements when the needs of the users change; and elasticity is the possibility of dividing the building into different functional units, or to extend the building horizontally or vertically[63]. Arge goes on

57 Avi Friedman, *The Adaptable House: Designing Homes for Change* (New York: McGraw-Hill, 2002), ix.
58 Stephen Kendall and Masao Ando, "Theory and Methods in Support of Adaptable Buildings" (paper presented at the Action for Sustainability: World Sustainable Building Conference, Tokyo, September 2005).
59 Ibid.
60 Friedman, *Adaptable House*, ix.
61 Ibid, x.
62 Kirsten Arge, "Adaptable office buidings: theory and practice", *Facilities* 23:3 (2005): 119.
63 Ibid, 121.

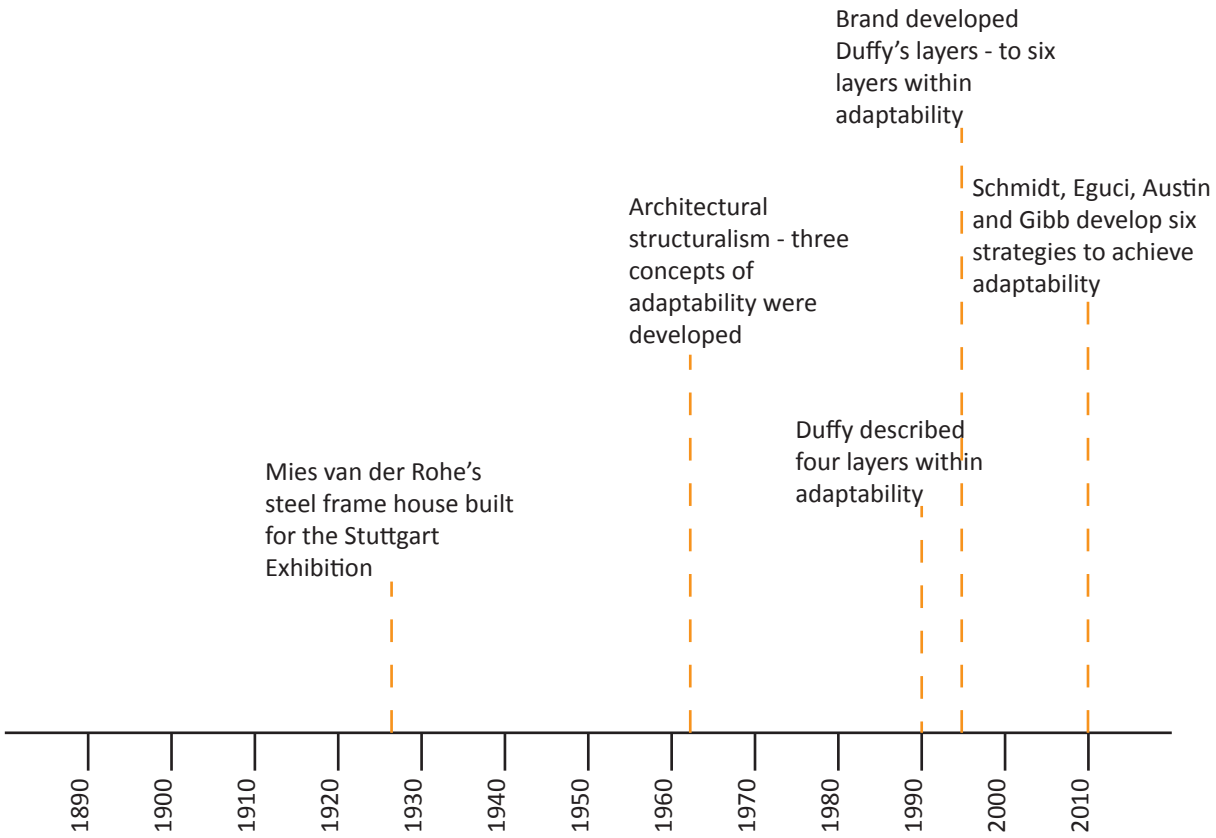


Figure 1.13 History timeline of adaptability strategies

to discuss what specific strategies can be used to achieve these three concepts, but in relation to commercial office buildings only. In this thesis, the transitional house will use the concepts of flexibility and elasticity.

Frank Duffy was the leading theorist of changes in buildings in the 1990s. He distinguished four layers within a building: shell, services, scenery and sets[64]. Brand later revised Duffy's layers, which were oriented towards the interior of commercial buildings, into six components which were more suitable for general buildings: site, structure, skin, services, space plan, and stuff[65]. This idea of adaptability is that a building is constructed from parts which have varying rates of usability, and that they require changing and replacing at different stages. Site, which is eternal, will last generations, whereas stuff – furniture, appliances, etc – will be moved or replaced regularly. The skin is more prone to change according to current styles, and services change regularly with updates in technology[66]. This idea of the time frame of different elements is of particular importance to the transitional house, where some components will be designed to last for the temporary phase only, and others will last longer term.

64 Francis Duffy, "Measuring Building Performance", *Facilities* 8:5 (1990): 17.
65 Stewart Brand, *How Buildings Learn: what happens after they're built* (New York: Viking, 1994), 13.
66 Ibid.

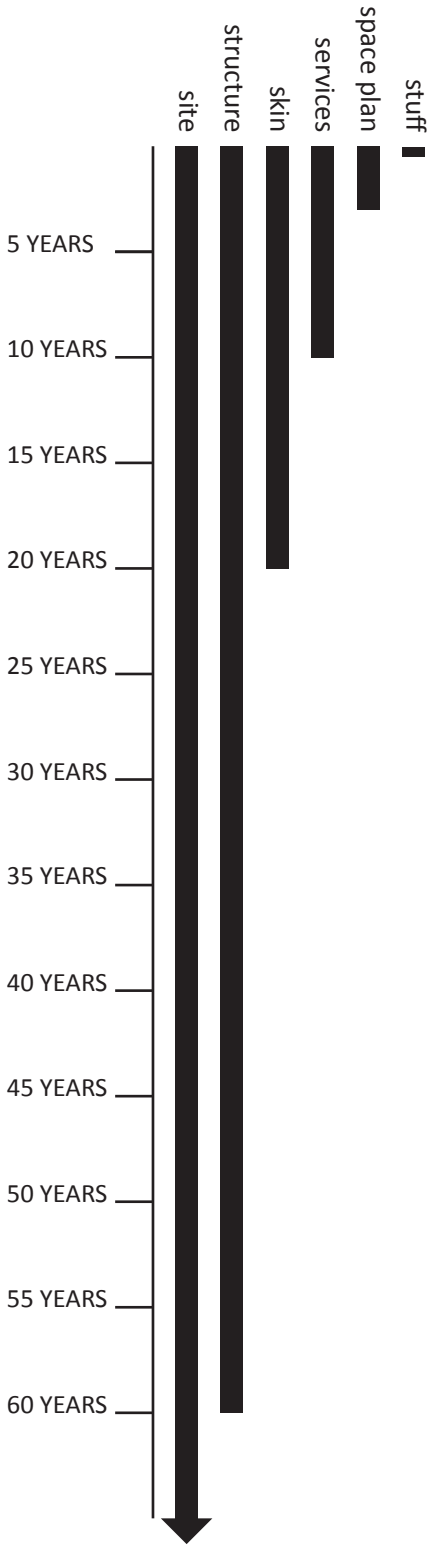


Figure 1.14 Brand's layers within a building

Schmidt et al's initial strategies:	Schmidt et al's revised strategies:	Transitional house strategies:
available	scalable	available
scalable	refitable	scalable
flexible	moveable	refitable
refitable	versatile	moveable
moveable	convertible	reusable
reusable	adjustable	versatile
		convertible
		adjustable

Figure 1.15 Strategies for adaptable housing

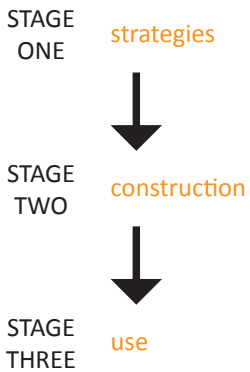


Figure 1.16 Three stages in which adaptability can take place

Schmidt, Eguci, Austin and Gibb initially developed six strategies to achieve adaptability: available, scalable, flexible, refitable, moveable and reusable[67]. After the authors reviewed literature, they attempted to confirm and compare their strategies. As a result, they eliminated available and reusable, and split flexible into versatile, convertible, and adjustable. The resulting six strategies were then: scalable, refitable, moveable, versatile, convertible, and adjustable.

As a housing response to disasters, the transitional house will use most of these strategies: scalable, versatile, convertible, refitable, movable, adjustable. However, as an emergency response, it will also use the eliminated strategy of available - which is the concern of quick delivery. As the transitional house mediates between temporary and permanent, the eliminated strategy of reusable is also included (refer figure 1.15).

There are three stages in which adaptability can take place.

> The first stage is initial design, where the designer employs strategies and components during the conception phase to facilitate pre- or post-occupancy adaptability. The second stage is construction, where the builders exercise the option of deciding on the project's main characteristics – for example, the number, types, and sizes of units – as well as a range of choices to be offered to buyers. The third stage is use, where, during occupancy, the homeowners exercise the previously conceived and constructed options for adaptability in the unit[68] (refer figure 1.16).

In the transitional house, all three stages will be utilised in order to create an adaptable design. This will be made feasible through prefabrication.

An understanding of adaptability brings an awareness of which techniques are relevant to particular projects. Designing for adaptability represents a departure from the traditional floor plan of fixed designs, and emerges as "an innovative strategy to increase the suitability of a small home to the dynamic of the family"[69]. Therefore, a brief can no longer be the starting point for adaptable architecture, and instead strategies must be employed at the design stage, which can be continued through to the occupation of the house[70].

67 Robert Schmidt et al, "What is the meaning of adaptability in the building industry?" (paper presented at the CIB 16th International Conference on Open and Sustainable Building, Bilbao, Spain, May 17-19 2010).

68 Friedman, *Adaptable House*, 12.

69 Ibid, 28.

70 Kendall "Theory and Methods".

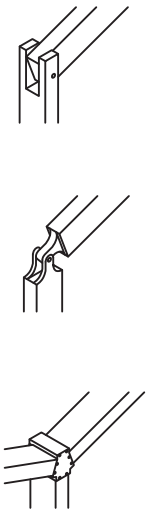
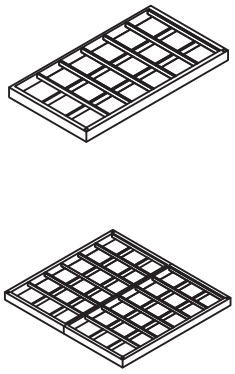
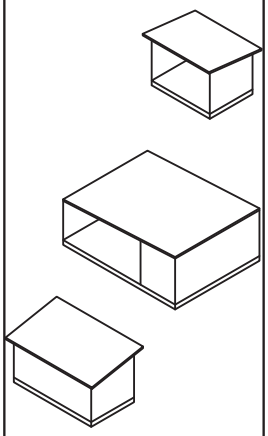
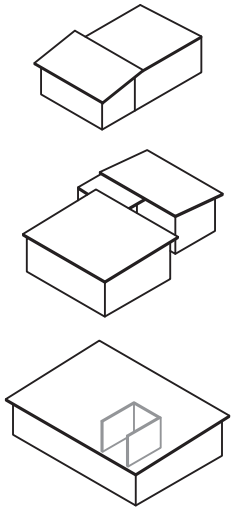
Component prefabrication (stick and sub-assembly)	Panel prefabrication (non-volumetric)	Module prefabrication (volumetric)	Hybrid prefabrication (module + panel)	Complete building prefabrication (box-form)
				
Complicated for amateurs, requires builder	Can be stacked flat, requires substantial assembly	Manufactured with services, highly resolved design	Allows for flexibility and choice	Highly resolved design, complete except for foundations

Figure 1.17 The five main types of prefabrication

Prefabrication typologies

> ***Today's prefab home is design rich, high-quality, and readily customised to individual sites and needs.***[71]

New Zealanders' perception of prefabricated houses is changing: the cheap, small, relocatable and standard homes are now perceived to more likely be an innovative blend of architecture, design, manufacturing and construction[72].

The five main types of prefabrication are: component (stick and subassembly), panel (non-volumetric), module (volumetric), hybrid (combination of systems) and complete buildings (box-form)[73].

In the transitional house, a hybrid method of panel and module prefabrication will be used. A hybrid method can be simple enough that it is possible to be constructed on site without a builder, but has enough flexibility in its design and constituent materials to remain adaptable. Prefabrication of the transitional house allows for ease of construction on site, which is vital for emergency housing. The changing public perception of prefabrication also suggests that the issue of cultural resistance will be lessened for post disaster housing.

The second part of this literature review has explored the strategies in adaptable design and prefabrication, and how these could be utilised in post-disaster housing. It has identified how adaptability can be incorporated in the design, construction and occupation stages of architecture; and explored the various options of prefabrication, of which a hybrid method would best suit the transportation and construction needs of the transitional house.

71 Pamela Bell and Mark Southcombe, *Kiwi Prefab: cottage to cutting edge: prefabricated housing in New Zealand* (Auckland: Balasoglou Books, 2012), 10.
72 Ibid.
73 Ibid, 36.

Summary

This literature review discusses current architectural discourse on disaster-relief housing, exploring the observed tendencies in humanitarian architecture. It suggests two implications to be considered for post-disaster housing. The first is that the failure to learn from previous humanitarian relief attempts has caused the reluctance to change. The second is that commonly detrimental issues in humanitarian relief include: responses which are insensitive and fail to meet the needs of the local people; relocation and its negative effect on reconstruction and emotional well-being; inadequacy in temporary shelters which have poor implications for long term reconstruction; and a failure to adequately prepare for disasters before they occur.

It also explores how ideas on adaptability and prefabrication can be incorporated into disaster-relief housing, in order to establish a new typology in post-disaster housing. It suggests two implications for the transitional house. The first is that adaptability should be incorporated into the design stage of the transitional house and the issue of time should be carefully considered as a primary strategy. The second is that numerous methodologies of prefabrication exist, of which a hybrid method would work best in the immediate phase after a disaster.

This research reveals the design problem in humanitarian relief housing and deploys strategies for ways in which architecture can appropriately meet these issues.

As a result of the strategies discovered in the literature review, the research objectives for the transitional house were formulated. These objectives are used as criteria to assess designs. As the assessment is subjective by nature, assumptions as to how the criteria are met have been made in order to evaluate the precedents and design tests fairly.

To explore how a temporary shelter can transition into a permanent dwelling.

This research objective was established from the *implications of time* section of the literature review, which reveals a transitional house as the best way to mitigate issues of time. When assessing precedent studies, it meets the criteria if was designed as transitional. For the design tests, the ease in which it can transition into a permanent dwelling is used to assess against the criteria.

To utilise modern fabrication techniques to aid in the efficiency of the construction on site.

This objective relates to the need for housing to be provided immediately in order to have relevance in a post-disaster situation, as discussed in the *implications of time* section. As revealed in *prefabrication typologies*, there are currently five fabrication techniques which result in efficient construction. For the precedent studies and design tests, the apparent complexity of construction is used to analyse the designs - if it is perceived to have simple panel, module or hybrid prefabrication methods then it meets the criteria.

To explore what pack-down techniques can offer in terms of storage and transportation of the components.

This research objective was created from the *preparedness* section. The ability to situate post-disaster houses at distribution centres simplifies the distribution process, resulting in quicker delivery. The degree of which the designs can pack-down into smaller volumes is analysed in both the precedent studies and the design tests, to assess against this criteria.

To offer a simple and cost-effective solution to housing through the use of prefabrication methods.

As established in the *preparedness* section, resourcing-related problems constrain the recovery process. If the transitional house is simple enough to be built without trained professionals, and made cost-effective though mass-production, it becomes a more feasible solution. The simplicity of the designs, resulting in mass-production and the ability to be built by untrained people, is assessed in the precedent studies and design tests to analyse the design's ability to meet the criteria.

To facilitate the siting of post-disaster shelters on peoples' own land if possible, or in their wider communities.

The *disadvantages of relocation* section of the literature review established this criteria, which highlights the positive implications when people are able to remain in their own communities. In the precedent studies assessment, the criteria is met if the foundation system has flexibility in its ability to occupy various land and terrain types. For the design tests, as the foundation system is not designed in detail, the ability of the overall house to suit various land and terrain types is used to assess against the criteria.

To allow for easy adaptation in order to suit individual needs.

This research objective was created from the *issues of context* section. As previous responses have failed to meet the local peoples' needs, the transitional house will be designed for a New Zealand context only. However, each domestic situation within New Zealand has different needs. Therefore, the transitional house needs the ability to be modified to suit the occupants' requirements. The strategies discussed in the *adaptable housing* section allows for adaptation at the initial stages, as well as throughout the life of the building in its state of permanence. The precedent studies and design tests are found to meet the criteria if they are able to be adapted at the initial and later stages of occupation.

This research reveals an adaptable transitional house as an answer to the design problem of post-disaster housing. The established research objectives are used to assess the suitability of the design of the transitional house in a post-disaster context.

Figure 1.18 Research objectives used as analysis criteria

Precedents

In this section, previous attempts to provide transitional housing, at both the conceptual and built stages, are examined against the established criteria. This analysis identifies the methods which previous architects have used to meet the research objectives of the transitional house.

As identified in the literature review, change is slow in coming to disaster relief due to the failure to learn from previous attempts. This analysis will learn from previous post-disaster housing and therefore aid in the realisation of the transitional house.

Paper Log House - Shigeru Ban

LOCATION:		Kobe, Japan
DATE OF CONSTRUCTION:		1995
SIZE:		52 sqm
LONGEVITY:		Temporary – able to be dismantled, materials disposed of or recycled
MATERIALITY:	ROOF:	Tenting material
	WALLS:	106mm diameter, 4mm thick paper tubes
	FOUNDATIONS:	Beer crates loaded with sandbags
	INSULATION:	Waterproof sponge tape with adhesive, sandwiched between paper tubes[74]

Figure 1.19 Japan Paper Log House. Source: Shigeru Ban, "Disaster Relief Projects".

74 "Disaster Relief Projects", Shigeru Ban, accessed April 1 2014, http://www.shigerubanarchitects.com/works.html#disaster-relief-projects

LOCATION:		Turkey
DATE OF CONSTRUCTION:		2000
SIZE:		18 sqm (3 x 6 m)
LONGEVITY:		Temporary
MATERIALITY:	ROOF:	Tenting material
	WALLS:	106mm diameter, 4mm thick paper tubes
	FOUNDATIONS:	Beer crates loaded with sandbags
	INSULATION:	Shredded wastepaper inserted inside paper tubes, fibreglass in ceiling, cardboard and plastic sheets as required[75]

Figure 1.20 Turkey Paper Log House. Source: Shigeru Ban, "Disaster Relief Projects".

75 "Disaster Relief Projects".

LOCATION:		Bhuj, India
DATE OF CONSTRUCTION:		2001
SIZE:		52 sqm
LONGEVITY:		Temporary
MATERIALITY:	ROOF:	Cane mat placed over bamboo ribs, followed by a clear plastic tarpaulin, and another cane mat
	WALLS:	106mm diameter, 4mm thick paper tubes
	FOUNDATIONS:	Rubble from destroyed buildings, coated with traditional mud floor
	INSULATION:	Ventilation provided through gables, with small holes in cane mats[76]

Figure 1.21 India Paper Log House. Source: Shigeru Ban, "Disaster Relief Projects".

76 "Disaster Relief Projects".

LOCATION:		Cebu, Philippines
DATE OF CONSTRUCTION:		2014
SIZE:		52 sqm
LONGEVITY:		Temporary
MATERIALITY:	ROOF:	Thatching of Nypa palms laid over plastic sheets
	WALLS:	Woven bamboo sheets applied to paper tube structural frame
	FOUNDATIONS:	Beer crates loaded with sandbags[77]

Figure 1.22 Philippines Paper Log House. Source: Shigeru Ban, “Disaster Relief Projects”.

77 “Disaster Relief Projects”.

In 2013, the construction methods of the Japan, Turkey and India paper log houses were acknowledged to be complicated and time-consuming to construct in high volumes[78]. For the Philippines paper log house, the connection system of Shigeru Ban's paper partition system was incorporated, to simplify the construction and therefore shorten the construction period. This new connection system was considered in the analysis of the paper log house criteria, rather than the previous construction methods.

78 "Disaster Relief Projects".

Figure 1.23 A comparison of Paper Log Houses. Source: Shigeru Ban, "Disaster Relief Projects".

Could the temporary shelter transition into a permanent dwelling?	
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	
Could the design facilitate siting on people's own land?	
Could the design be easily adaptable to suit individual needs?	

Figure 1.24 Analysis of the Paper Log House

Fill_Frame - Allison Powell

LOCATION:		Panabaj, Guatemala
DATE OF CONSTRUCTION:		Unbuilt
SIZE:		24.7 sqm (3.8 x 6.5 m), or 18.2 sqm (3.8 x 4.8 m)
LONGEVITY:		Transitional – structural frame system covered with nylon for the temporary, and infill wall panels as the permanent
MATERIALITY:	ROOF:	Recycled plastic trusses with metal roofing
	WALLS:	Bamboo structural frame system, with nylon emergency material and then local natural materials used as infill wall panels
	FOUNDATIONS:	Plastic shipping pallets[79]

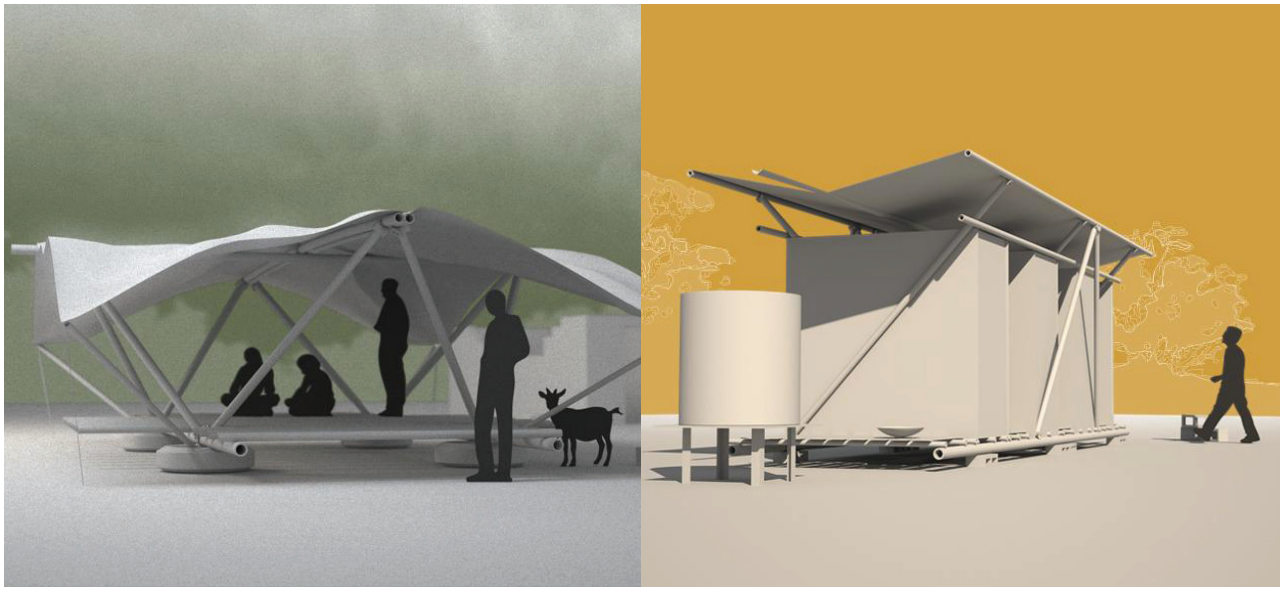
Figure 1.25 Fill_Frame. Source: Studio Recover, "Fill_Frame".

79 "Fill_Frame", Studio Recover, accessed April 1 2014, http://www.studiorecover.virginia.edu/fullsite/projects/fillframe.pdf

Could the temporary shelter transition into a permanent dwelling?	
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	
Could the design facilitate siting on people's own land?	
Could the design be easily adaptable to suit individual needs?	

Figure 1.26 Analysis of Fill_Frame

Generative Relief Shelter - Mac Lanphere



LOCATION:		Unspecified location
DATE OF CONSTRUCTION:		Unbuilt
SIZE:		20 – 30 sqm
LONGEVITY:		Transitional – temporary reconfigured to permanence, through the reuse of material
MATERIALITY:	ROOF:	Flexible roofing applied to wall structure
	WALLS:	Triangulated bamboo structural frame
	FOUNDATIONS:	Bamboo structure[80]

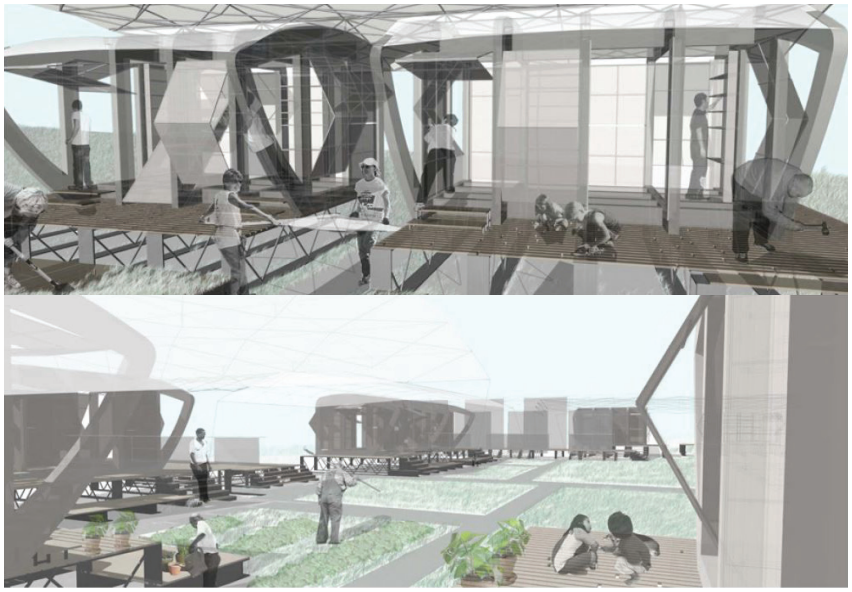
Figure 1.27 Generative Relief Shelter. Source: Open Architecture Network, "Generative Relief Shelter".

80 "Generative Relief Shelter", Open Architecture Network, accessed April 1 2014, http://openarchitecturenetwork.org/projects/generative_relief_shelter

Could the temporary shelter transition into a permanent dwelling?	
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	
Could the design facilitate siting on people's own land?	
Could the design be easily adaptable to suit individual needs?	

Figure 1.28 Analysis of Generative Relief Shelter

Community Revival - Eddie Layton and Greta Modesitt



LOCATION:		Chalmette, Louisiana
DATE OF CONSTRUCTION:		Unbuilt
SIZE:		Size customised at fabrication stage
LONGEVITY:		Temporary - able to be dismantled and materials reused
MATERIALITY:	ROOF:	Tensile marine canvas skin on tubular frame
	WALLS:	Laminated corrugated cardboard structural frame, with cardboard infill panels
	FOUNDATIONS:	Steel base system, on concrete pad foundation
	INSULATION:	Thin layer of thermal insulation at roof, rigid wall and floor insulation[81]

Figure 1.29 Community Revival. Source: Studio Recover, "Community Revival".

81 "Community Revival", Studio Recover, accessed April 1 2014, http://www.studiorecover.virginia.edu/fullsite/projects/communityrevival.pdf

Could the temporary shelter transition into a permanent dwelling?	
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	
Could the design facilitate siting on people's own land?	
Could the design be easily adaptable to suit individual needs?	

Figure 1.30 Analysis of Community Revival

SECTION TWO:

DESIGN PROCESSES

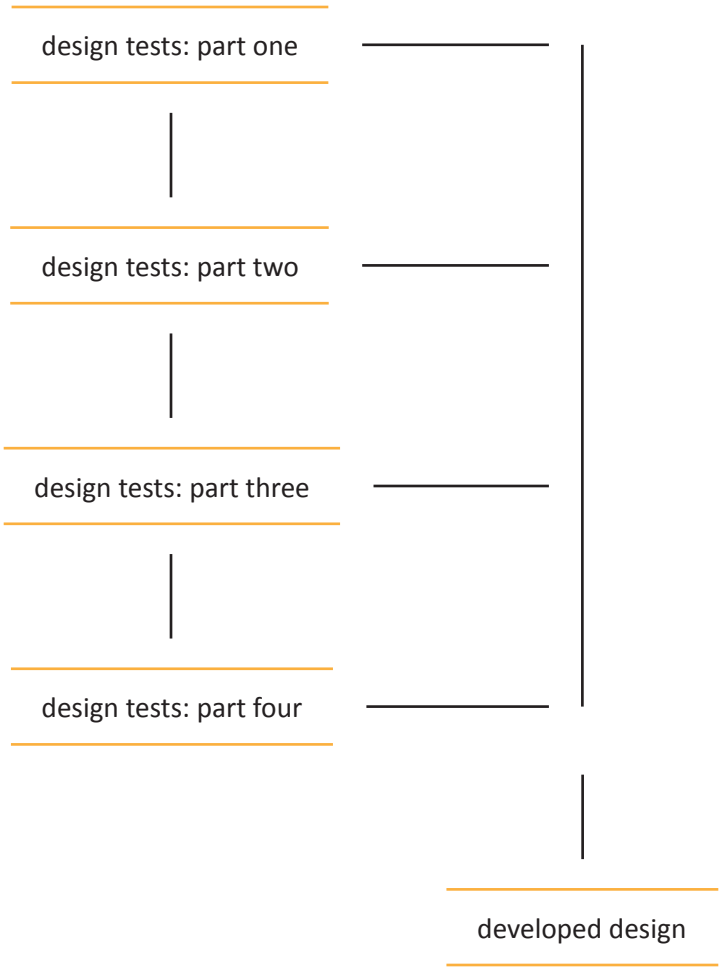


Figure 2.1 Design processes structure diagram

Part one

The initial design testing considered the idea of adaptability – could the shelter be designed through a digital parametric process so that it could be customised to the individual prior to construction?

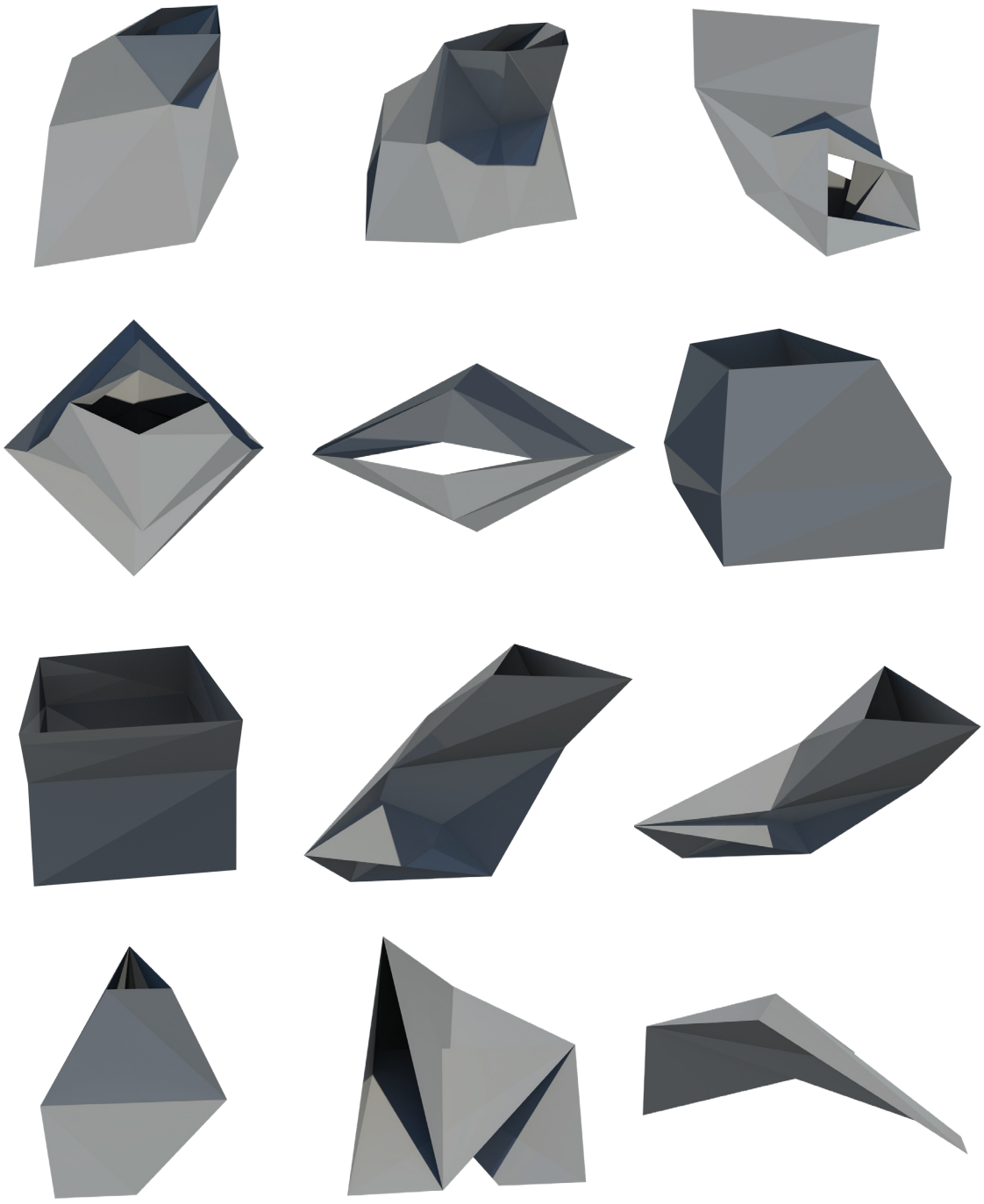


Figure 2.2 Explorations into how the digital modelling program *rhino* and it's parametric design plug-in *grasshopper* can aid in the development of an adaptable house

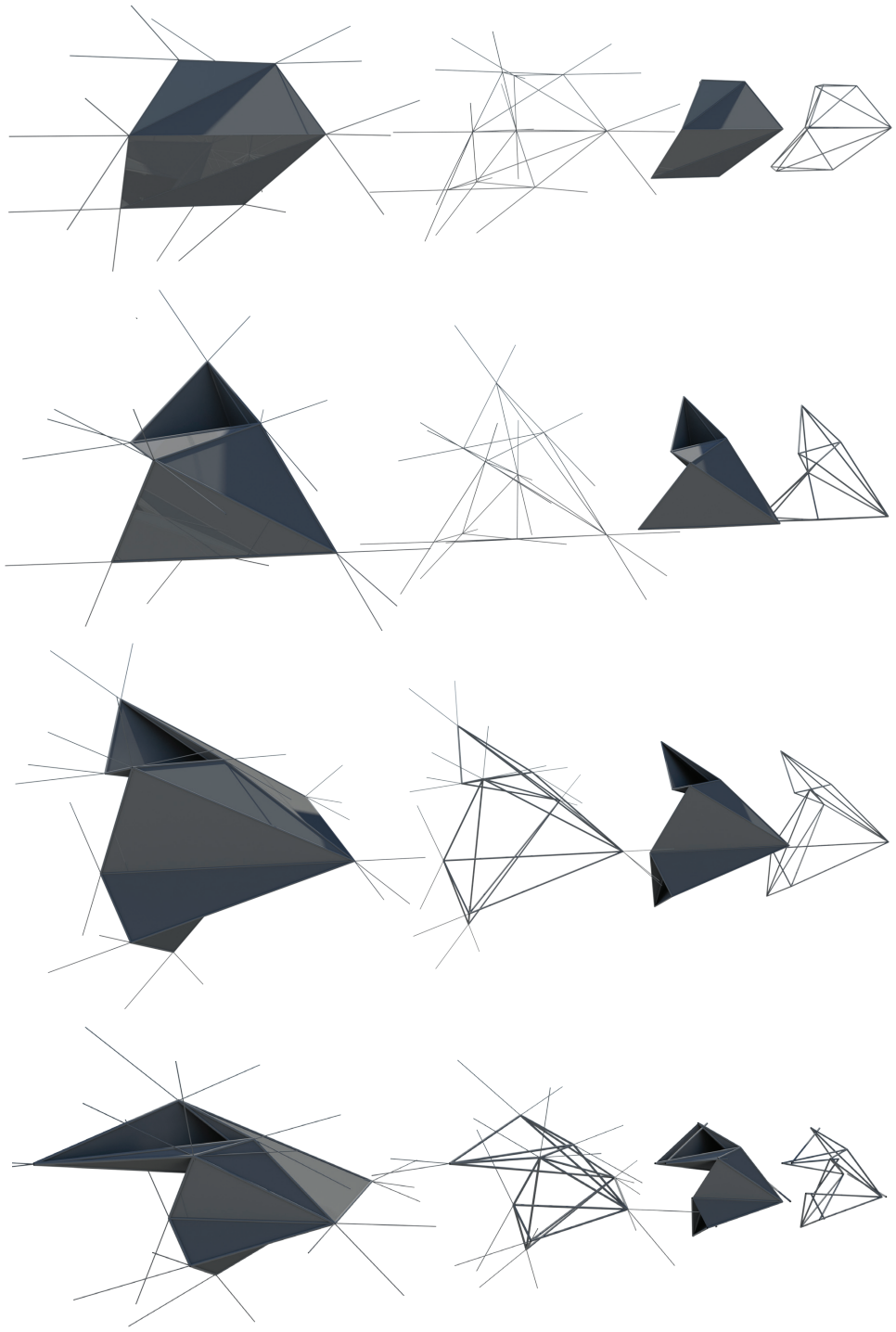


Figure 2.3 Explorations into how *rhino* and *grasshopper* can create a structure for the transitional house

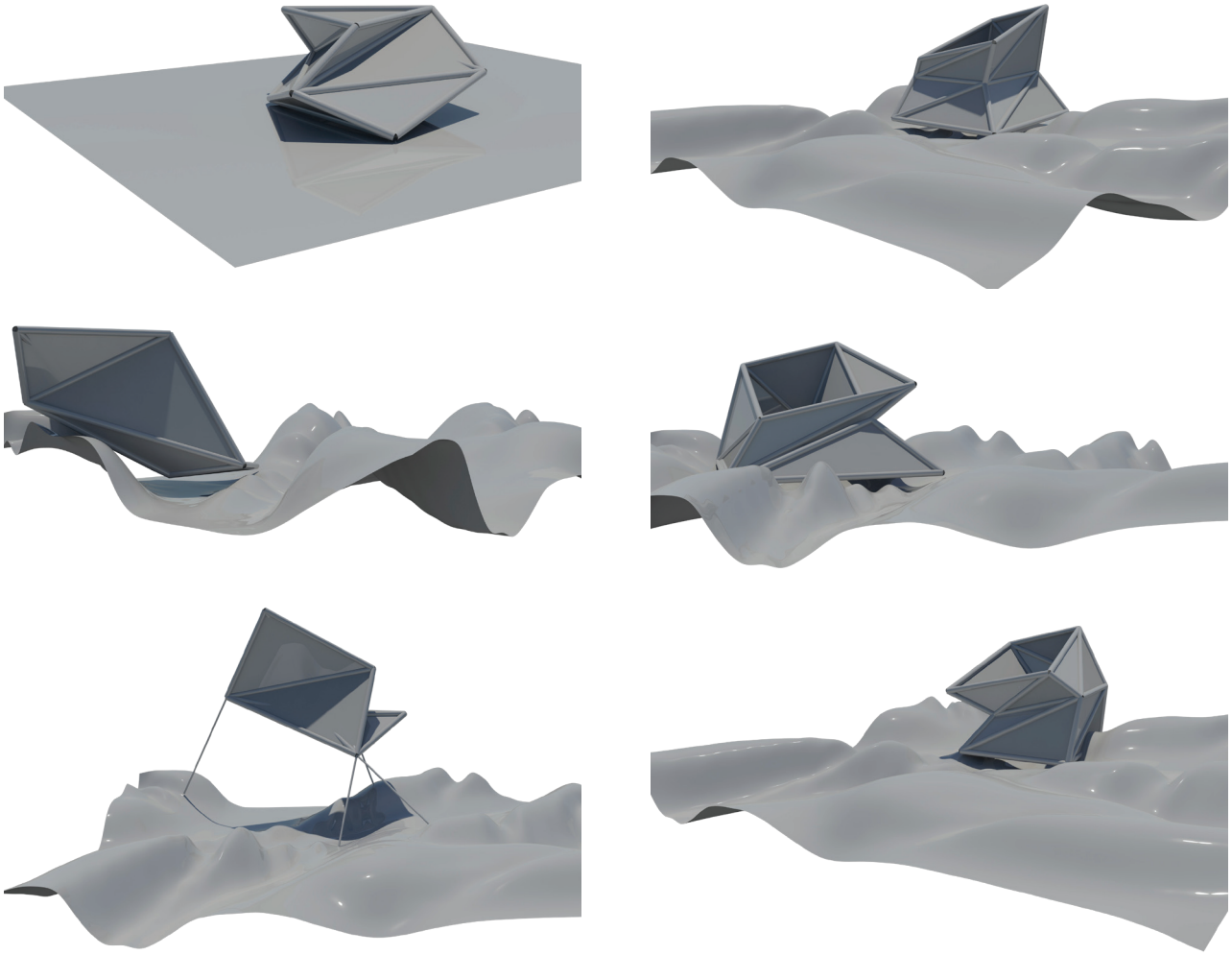
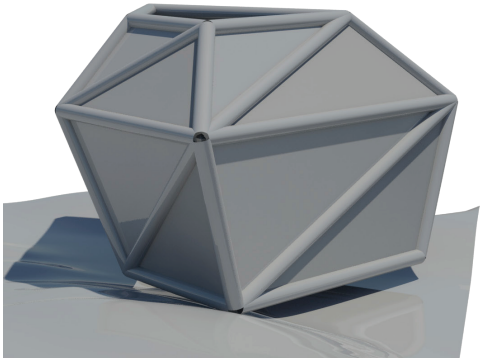
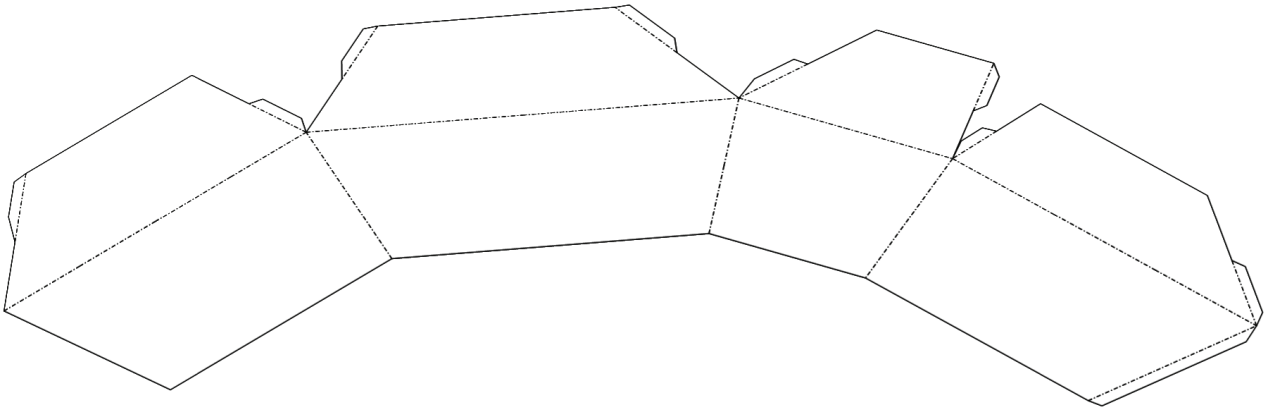


Figure 2.4 Explorations into how a single form may be adapted in order to suit multiple contexts





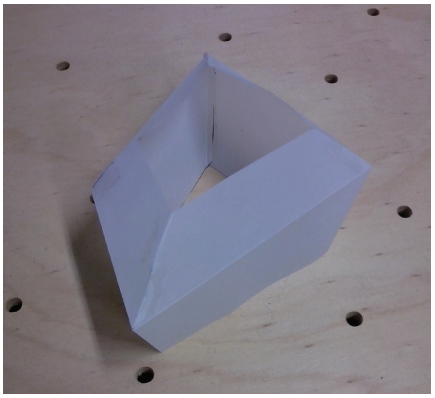


Figure 2.5 Unfolding forms into nets, creating a flat-pack system which allows for transportation

Could the temporary shelter transition into a permanent dwelling?	
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	
Could the design facilitate siting on people's own land?	
Could the design be easily adaptable to suit individual needs?	

These design explorations were successful in generating formal ideas, but as a design solution they were unable to resolve the issues of the transitional house. The forms show little room for expansion into a permanent dwelling, nor offer a simple cost-effective solution. Furthermore, the unusual forms may result in a cultural and/or spatial resistance to the shelters. While parametric modelling allows for adaptation in order to suit individual people and contexts, this can make the manufacturing and delivery process overly complex. These design tests highlight the issue of practicality which this research aims to further resolve.

Figure 2.6 Analysis of design processes part one

Part two

The second stage of design testing considered the failure of practicality in the first tests, and established the need for practical structural systems – how might the systems be designed in order for storage and transportation?

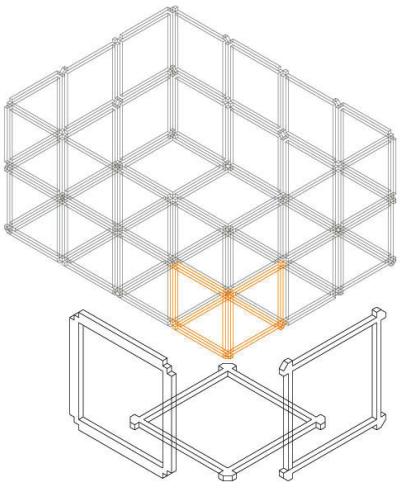


Figure 2.7 A clip-together structural wall system

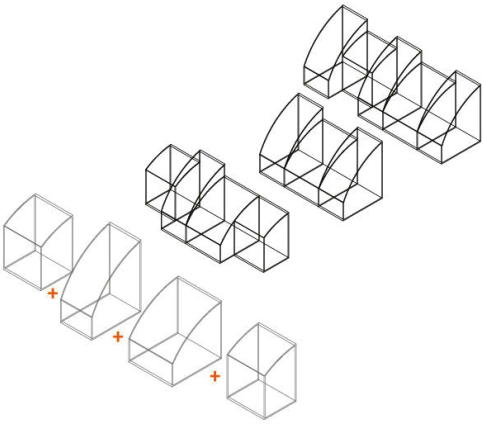


Figure 2.8 Prefabricated modules are manufactured in different sizes and can contain any number of necessary modules within a linear arrangement

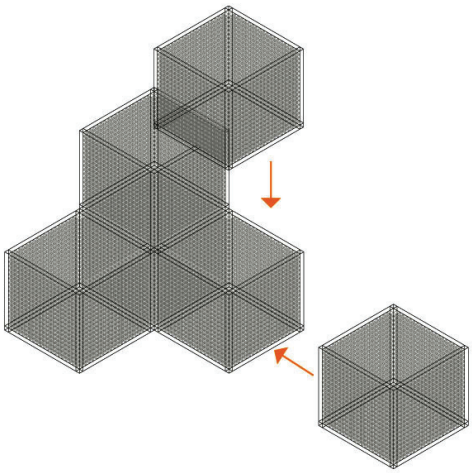


Figure 2.9 Flat-pack boxes are filled with rubble and used as walls for the shelter

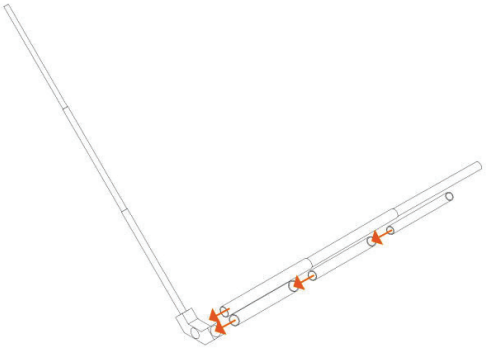


Figure 2.10 Telescoping structural members are used with a custom-designed connection unit

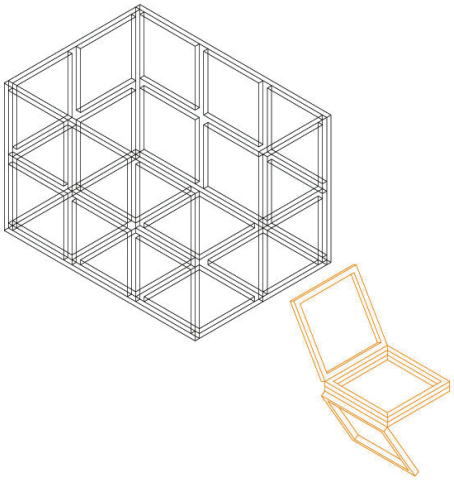


Figure 2.11 A fold-down structural wall system

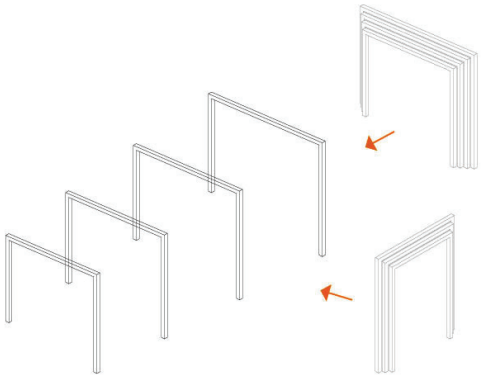


Figure 2.12 Structural frames are manufactured in different sizes, so that they can nest together for storage and transportation

Could the temporary shelter transition into a permanent dwelling?	
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	
Could the design facilitate siting on people's own land?	
Could the design be easily adaptable to suit individual needs?	

This set of design tests were successful in considering how structure can be designed for compact storage and easy transportation, but do not offer a formal design solution. While structural systems are vital for temporary housing, they should not dictate the design form. These design explorations can be used to inform the structural system of the transitional house when its form has been realised.

Figure 2.13 Analysis of design processes part two

Part three

The third set of design tests addresses the transitional aspects of the design problem – how might a temporary dwelling transition into a permanent home? Will this primary concept drive a formal response in a manner in which the second design tests were unable to do?

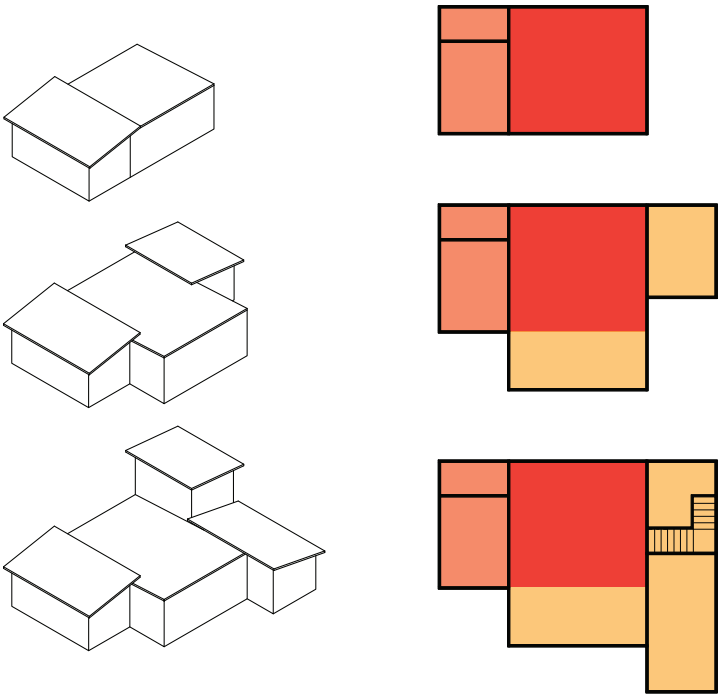


Figure 2.14 The living room as a core to expand from (plans not to scale)

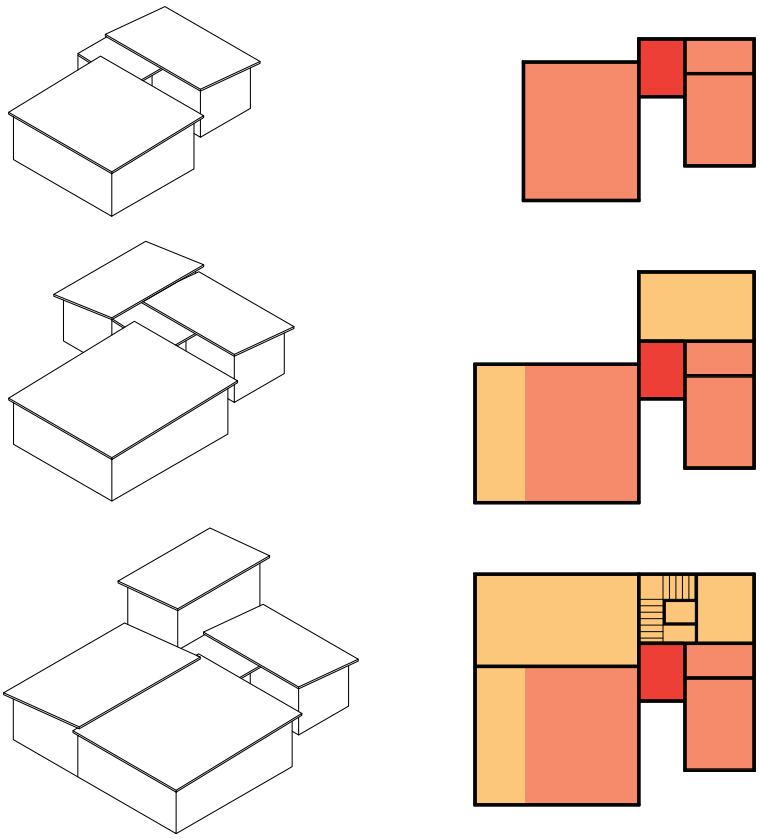


Figure 2.15 The pod as a core to expand from (plans not to scale)

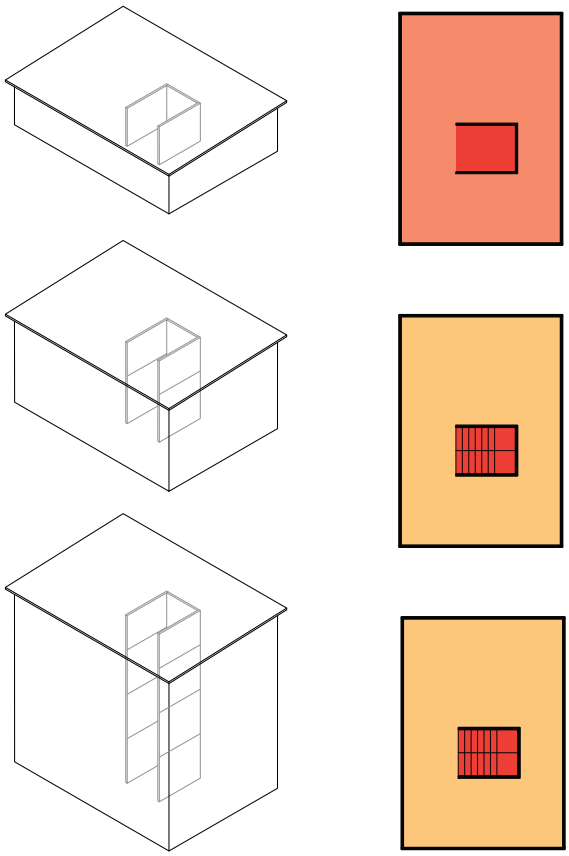


Figure 2.16 The staircase as a core to expand from vertically (plans not to scale)

Could the temporary shelter transition into a permanent dwelling?	
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	
Could the design facilitate siting on people's own land?	
Could the design be easily adaptable to suit individual needs?	

These explorations were successful in exploring the adaptation process from temporary to permanent, but are too close to the common housing typologies to work in a post-disaster situation. The shelter needs to be small at the temporary stage, and does not need to be reminiscent of a typical New Zealand home. This design idea of growing modules is adapted for subsequent design tests, as it addresses both the transitional and adaptable aspects of the research.

Figure 2.17 Analysis of design processes part three

Part four

After the growing module idea was established in the third set of design tests, these design tests explored the transitional process in a less conventional form – how might a modular system assist in the transitional period from temporary to permanent?

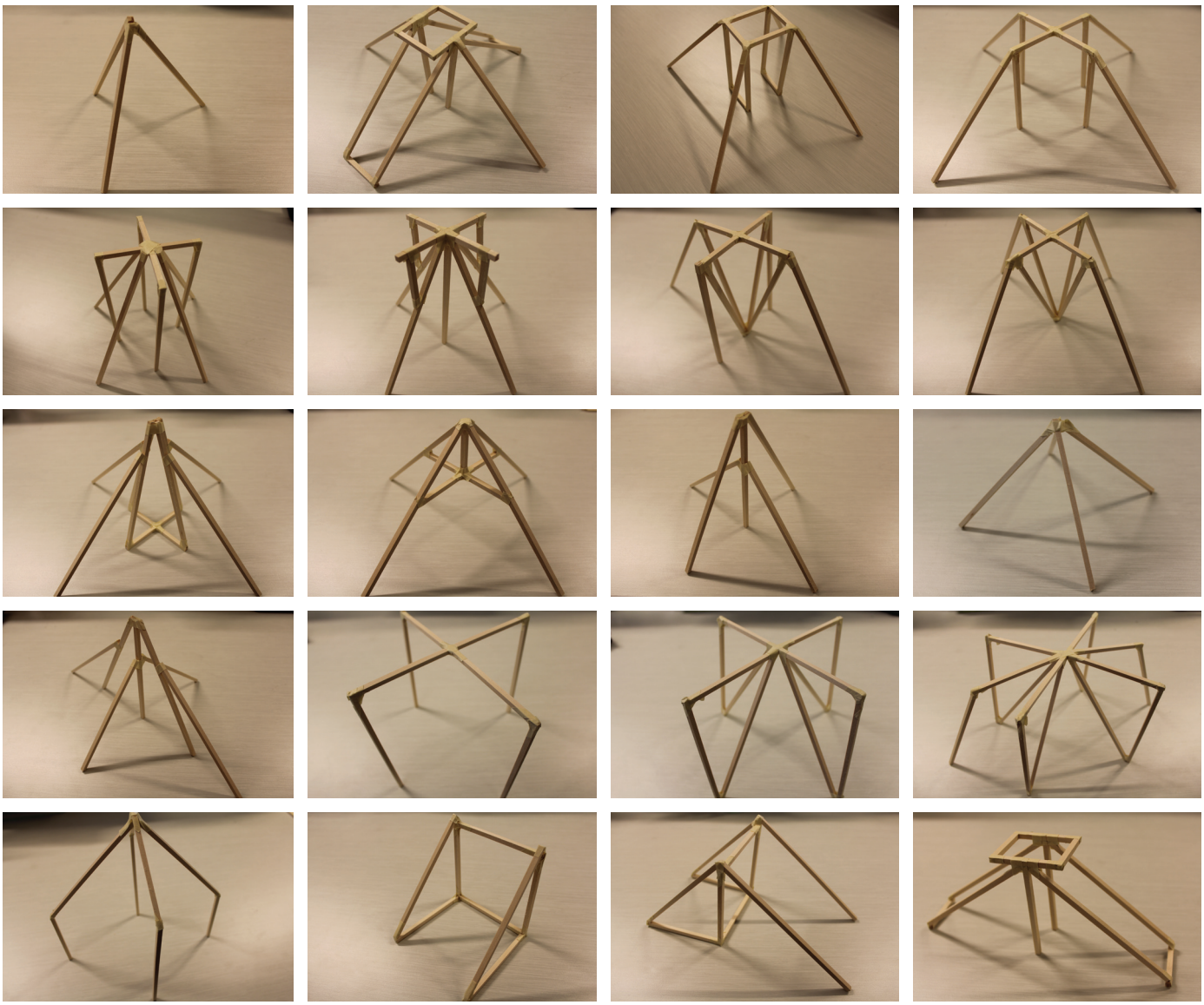


Figure 2.18 Physical models, testing strong structural forms

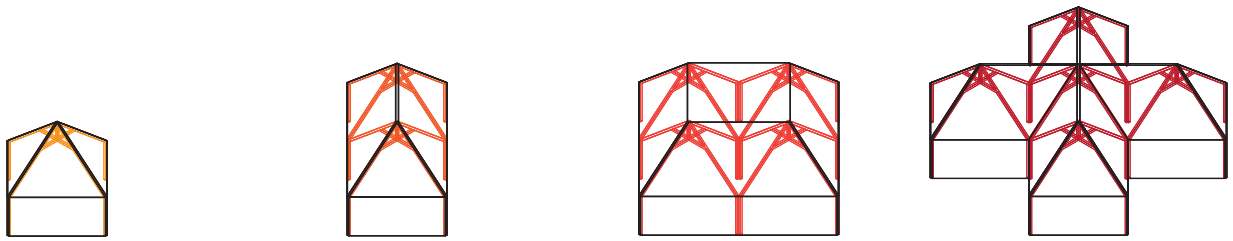


Figure 2.19 Explorations into how the modular system might grow

Figure 2.20 Testing of spatial configurations

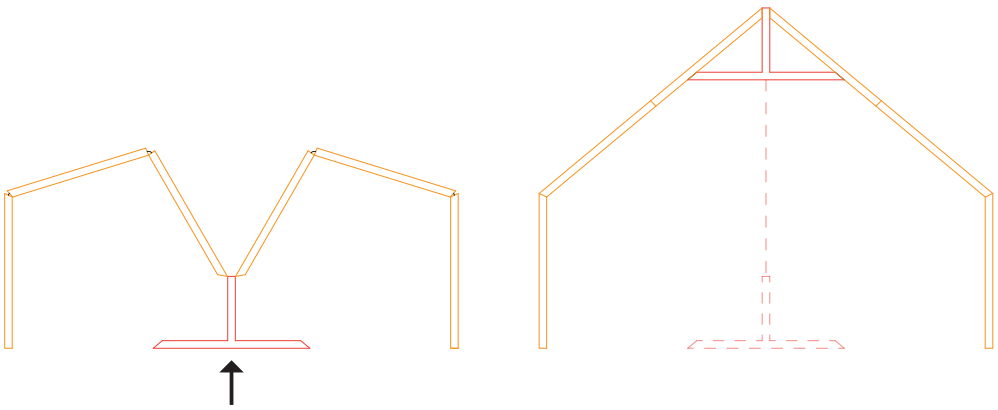


Figure 2.21 Exploring how the structure might be constructed - scale 1:100

Could the temporary shelter transition into a permanent dwelling?	—
Did fabrication techniques aid in the efficiency of construction on site?	
Did pack-down techniques offer easy storage and transportation of the components?	
Did prefabrication methods offer a simple and cost-effective solution?	—
Could the design facilitate siting on people's own land?	—
Could the design be easily adaptable to suit individual needs?	

These design explorations expanded upon the ideas in the third set of design tests, but in another form. However, the unusual forms may result in a cultural resistance to the dwelling. While additional modules can be added in order to meet individuals' requirements, the transition from a temporary shelter to a permanent dwelling will be difficult due to the unique form of the shelter. In order to allow for easy assembly, the construction of the shelter system would need to rely on kinetic robotic engineering. The resilience of the robotic engineering necessary for transportation would be difficult to achieve within the scope of this thesis. Therefore, a simple structural system and method of assembly would work best for the transitional house.

Figure 2.22 Analysis of design processes part four

Summary

The implications of these tests are analysed in order to fully realise the developed design. In each design test, either the unusual form has resulted in the difficulty to meet other objectives, or the lack of a formal design has been due to the concentrated efforts on other criteria. In the next stage of design, design ideas will be rapidly formed and assessed against the criteria, and the form will then be developed alongside other aspects.

Through design tests, it has been established that the transition from a small shelter to a unique permanent dwelling needs to be staged, such as the explorations of growth in test three. While adaptation of the transitional house should be available, this should be limited to what can be done on-site or at a later stage. The adaptation of designs at the pre-deployment stage creates additional difficulty in the manufacture and transportation of the units. The solution lies in a simple construction system, which balances ease of assembly with storage and transportation issues.

SECTION THREE:

DEVELOPED DESIGN

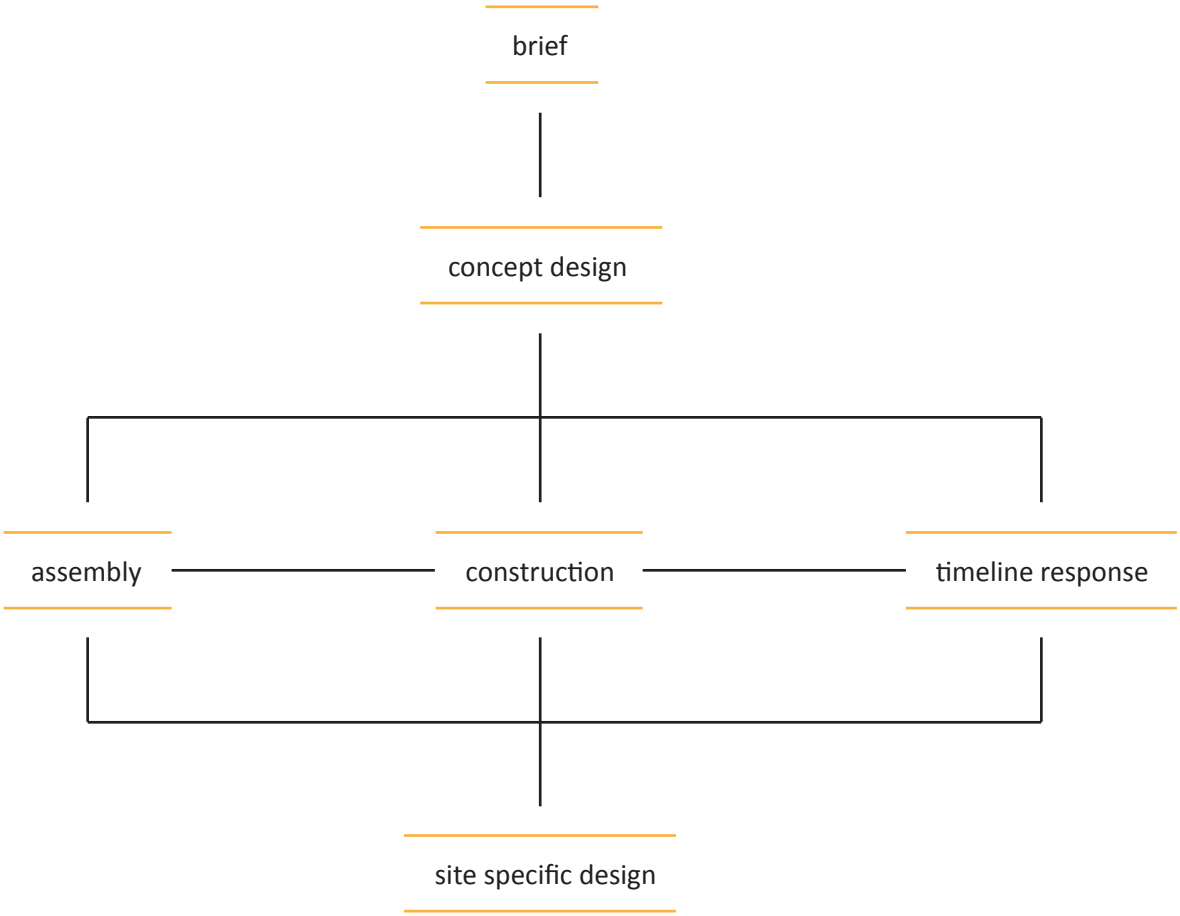


Figure 3.1 Design development structure diagram

Brief

The transitional house must meet the requirements already established within the aims and objectives of the thesis in chapter one:

How can a temporary shelter transition into a permanent dwelling?

How can modern fabrication techniques aid in the efficiency of the construction on site?

What can pack-down techniques offer in terms of storage and transportation of the components?

How can prefabrication methods offer a simple and cost-effective solution to housing?

What can the design include in order to facilitate the siting of post-disaster shelters on people's own land if possible, or in their wider communities?

How can the transitional house be easily adaptable to suit individual needs?

The Sphere Handbook provides general standards for response scenarios, including temporary and transitional shelters on original sites. This has provided additional requirements for the transitional house:

People should be supported to build new structures[82]. Therefore, the assembly of the transitional house needs to be simple enough for a layman to undertake.

A covered floor area in excess of 3.5 square metres per person[83]. Based on an average household number of four people, the transitional house must be at least 14 square metres.

The internal floor-to-ceiling height should be a minimum of two metres at the highest point[84]. In order to provide spaces reminiscent of a housing situation in New Zealand, the transitional house should provide generous floor-to-ceiling heights.

If a complete shelter cannot be provided, roofing materials to provide the minimum covered area should be prioritised[85].

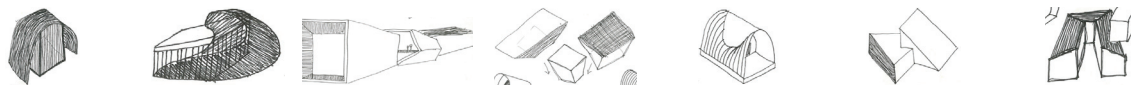
Shelters should be informed by assessments of existing typical housing[86].

82 "Minimum standards in shelter, settlement and non-food items", The Sphere Project, accessed May 1 2014, http://www.spherehandbook.org/en/how-to-use-this-chapter-2/ , 246.
83 Ibid, 259.
84 Ibid.
85 Ibid.
86 Ibid, 260.

Concept design

After establishing further requirements in the brief, sketching was used to rapidly explore different forms. These forms were then tested against the criteria to quickly eliminate options.

Design Concept Three



After assessing the formal explorations against the criteria, a clear pattern emerged among those forms which met all six of the criteria. The three tests which met the criteria all involved the idea of folding or extending outwards. This idea was then explored through a simple rectangular form, which met the requirements of the brief.

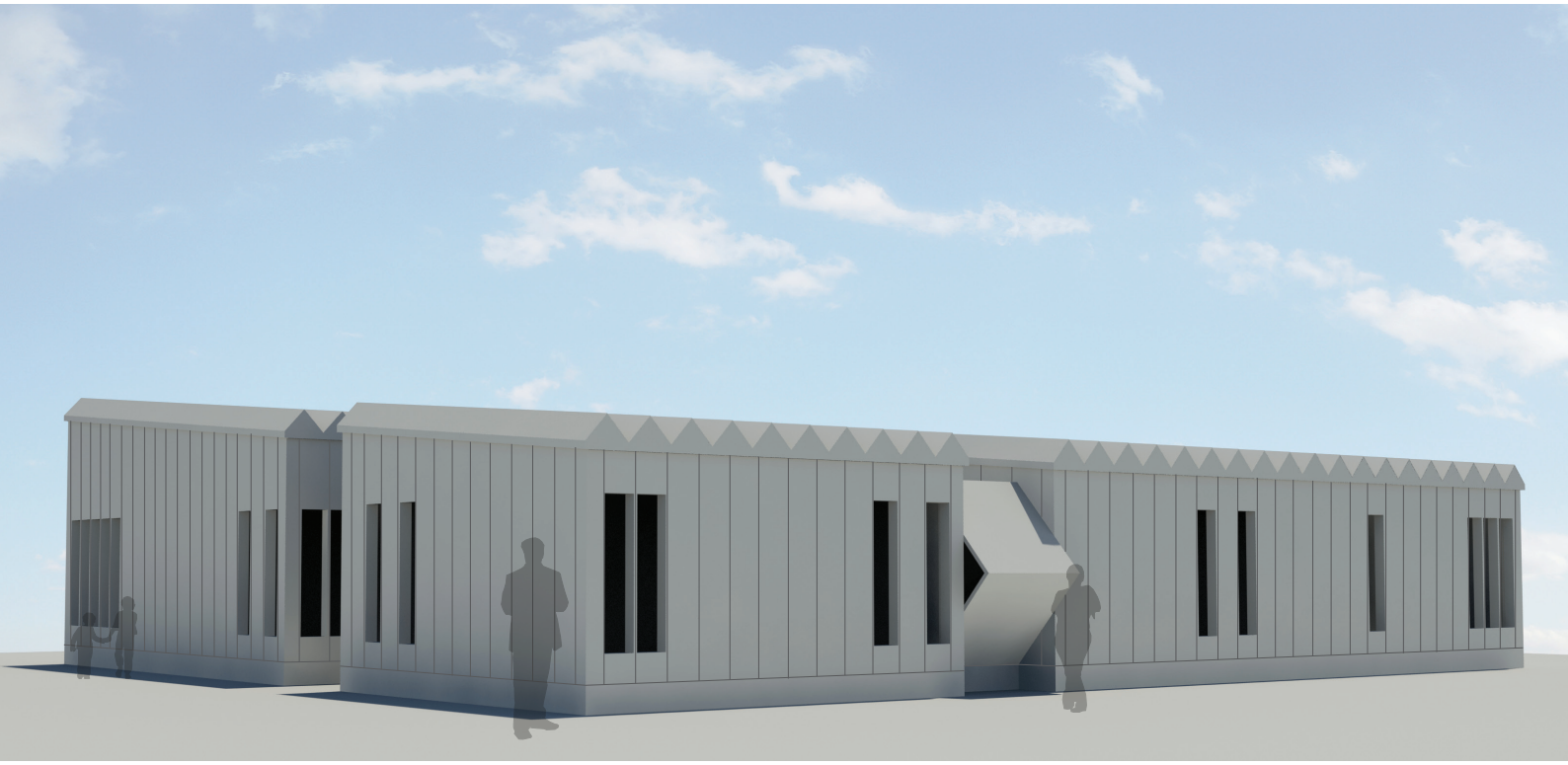


Figure 3.3 Development of the design idea of folding and extending

During the development of the design, the simple rectangular form has remained. This is due to the need of the research to meet its objectives, rather than a need to produce visually wild architecture.

Due to the limitations of a Masters thesis, parts of the transitional house are resolved to a higher level of detail, while some are explored conceptually only.

In a post-disaster situation, it is important to provide shelter as well as the tools to live - furniture, bedding, etc. This idea is explored diagrammatically (refer to figure 3.6).

One of the research objectives asks if the design could facilitate siting on people's own land. This is achievable through the use of an adaptable foundation system. Initially this will be a simple solution, due to simplified construction requirements. Due to the limitations of a design-as-research thesis, this idea is only briefly explored (refer to figure 3.7). For the rest of the thesis, appropriate adaptable foundations are assumed.

The electrical and plumbing needs of the kitchen and bathroom have not been specifically designed. Instead, these are assumed to be built in to the modules. It is also assumed that the necessary infrastructure will be in place before the modules arrive (two - four weeks post-disaster).

The following aspects are further developed:

The methods of assembly are developed through sketches, and tested with partial physical models.

Construction of the initial shelter is explored through a 1:10 physical model and detail drawings. Construction of other building elements is not resolved.

The transitional aspect is explored in the timeline response, which evaluates previous responses and suggests a more appropriate timeframe. The linking module used in the transitional house has been adapted from the Industrialised Building System, which was designed in New Zealand between 1968 and 1978 (refer figures 3.4 and 3.5).

The suitability of the transitional house is then tested on four Wellington sites.

These design developments seek to prove the transitional house as an answer to the problems of post-disaster housing. Throughout this section, it is noted where the transitional house has met the research objectives.

Figure 3.4 IBS house. Source: “IBS Comes to Life”, 1.

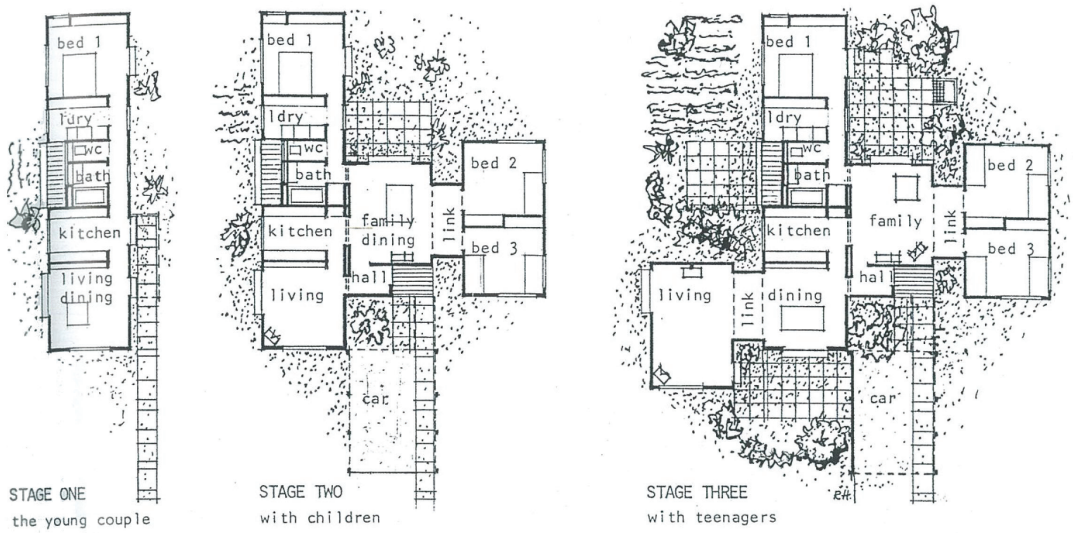


Figure 3.5 Three plans of IBS extendable house. Source: Bell, *Kiwi Prefab*, 29.

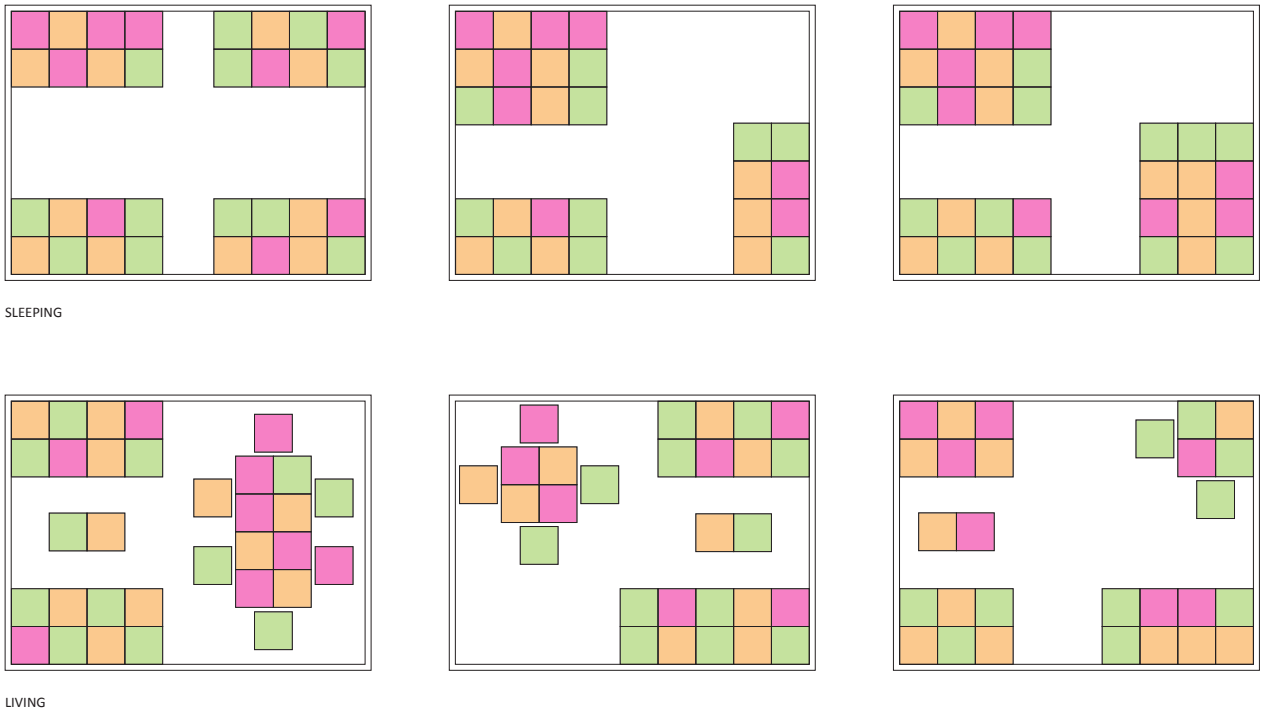


Figure 3.6 Diagrammatic furniture configurations - scale 1:100. The proposed furniture in the initial transitional shelter are boxes, which can be reconfigured in various ways in order to form furniture for sleeping, resting, eating, etc. The boxes are hollow, and can be used as storage.

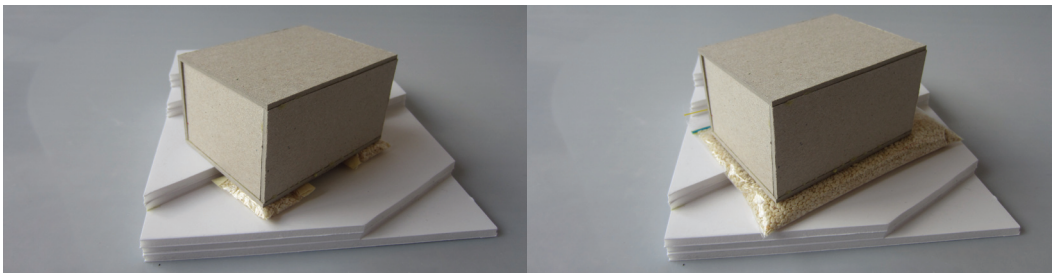


Figure 3.7 Initial foundation explorations. The transitional house needs to be situated on a variety of sites, but also requires easy assembly. Therefore, a simple foundation system is proposed for the initial stages. At a later stage, adjustable foundations will be attached to the transitional house by contractors.

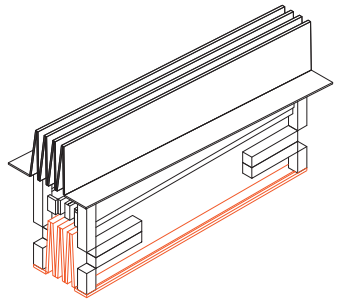
The design facilitates siting on people's own land

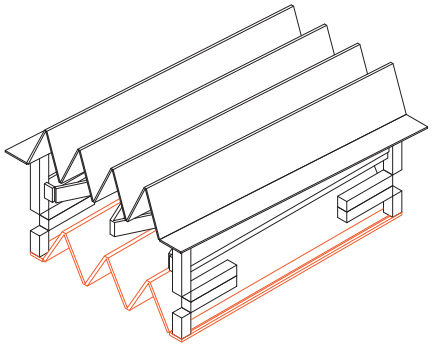
Assembly

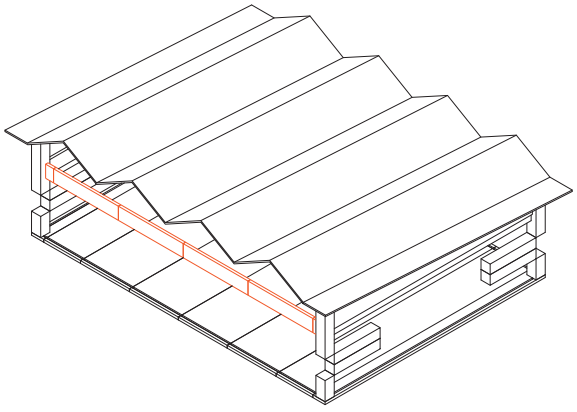
Once the form had been established, and the idea of folding or extending outwards realised as integral to the design, the method of assembly was then considered.

Due to prefabrication, the shelter can arrive on site without substantial assembly required - however, due to size restrictions in the storage and transportation phases, some assembly would still be necessary.

Assembly sequence







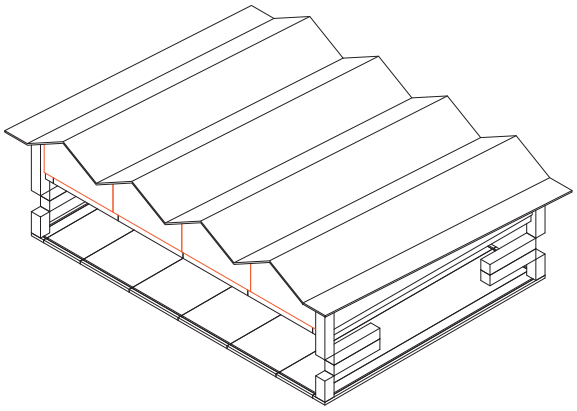
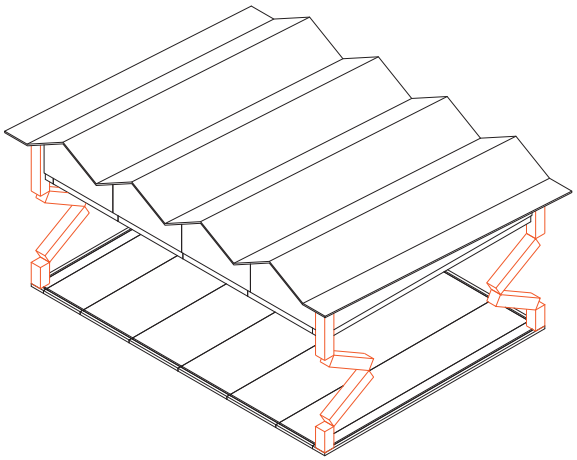
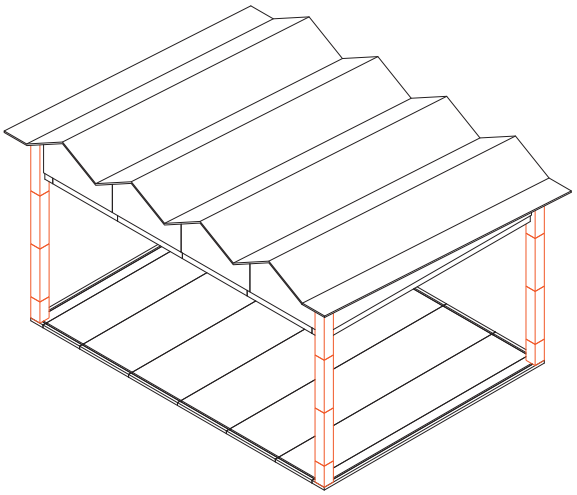
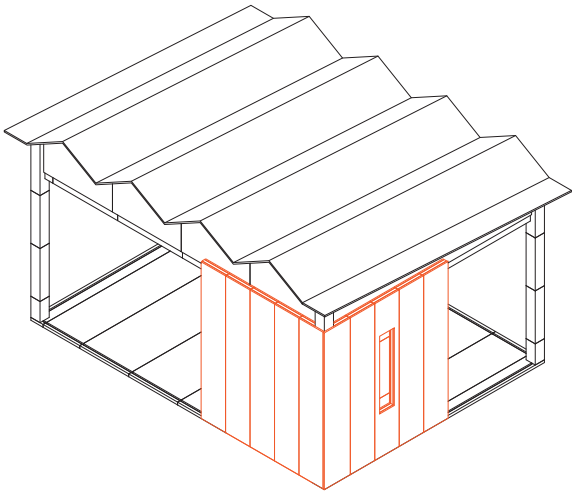


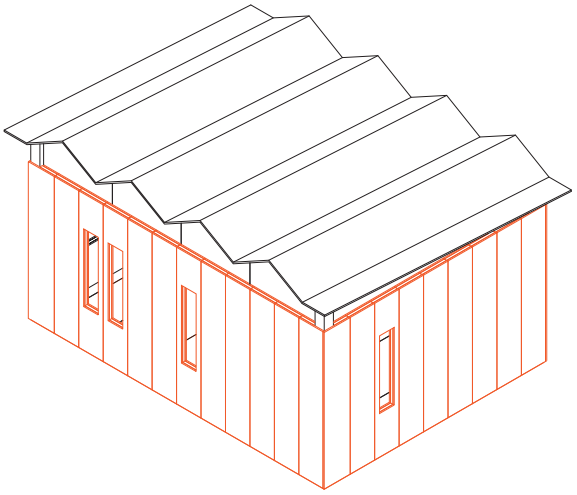
Figure 3.8 Sequence of assembly (cont. on facing page)

Prefabrication techniques aid in the efficiency of construction on site 24H









Assembly method tests

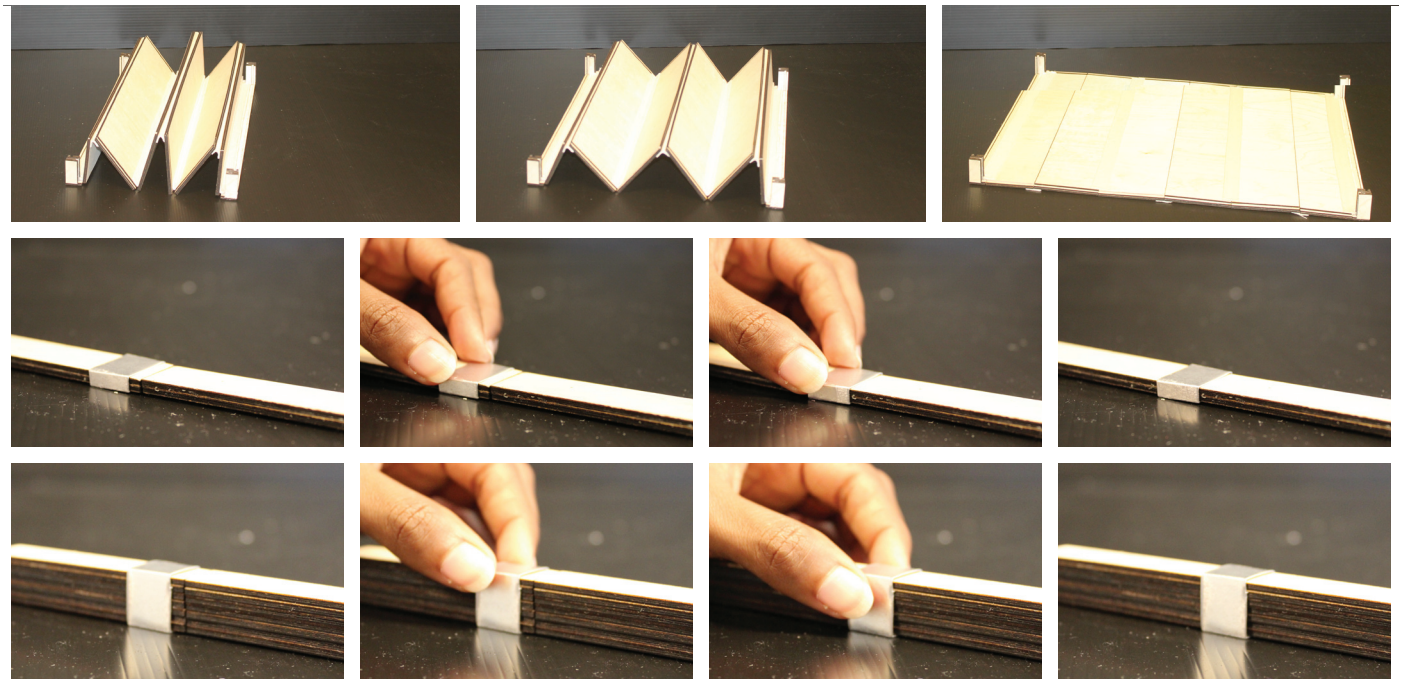
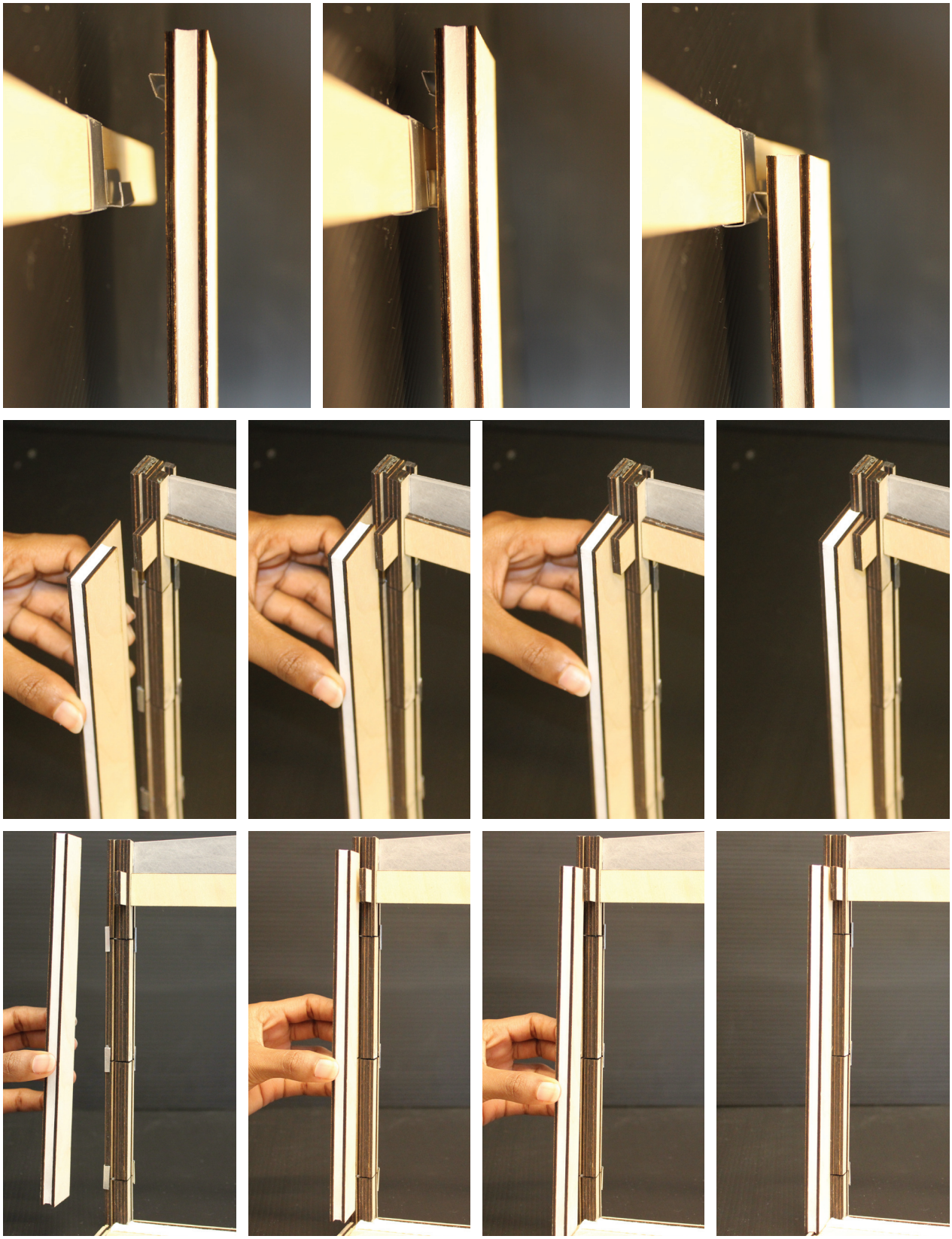
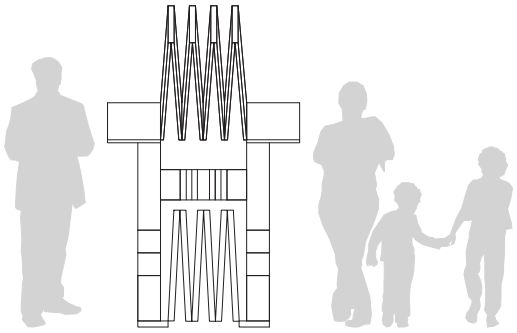


Figure 3.9 Methods of assembly shown through 1:10 test model: concertina of the floor; sliding connections at the beam; sliding connections at the column

Figure 3.10 (facing page) cladding panels clip onto beam; cladding sits inside groove of column; cladding sits inside groove of floor



Ease of construction



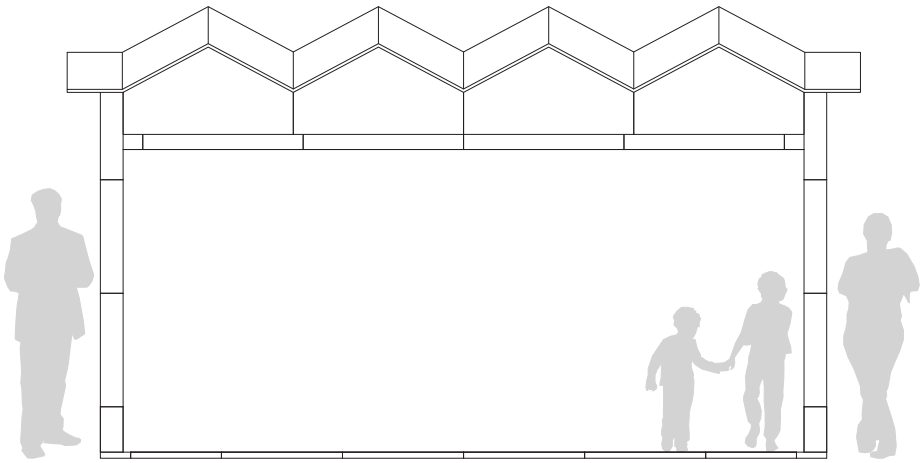


Figure 3.11 Diagram of the shelter assembly - scale 1:50

Pack-down techniques offer easy storage and transportation

The shelter can be assembled by two adults:

Pack down size is
- 3.6m wide
- 0.97m deep
- 1.48-1.68m to the bottom of roof
- 1.92-2.12m to the top of roof

Connection points are in easy reach of adults

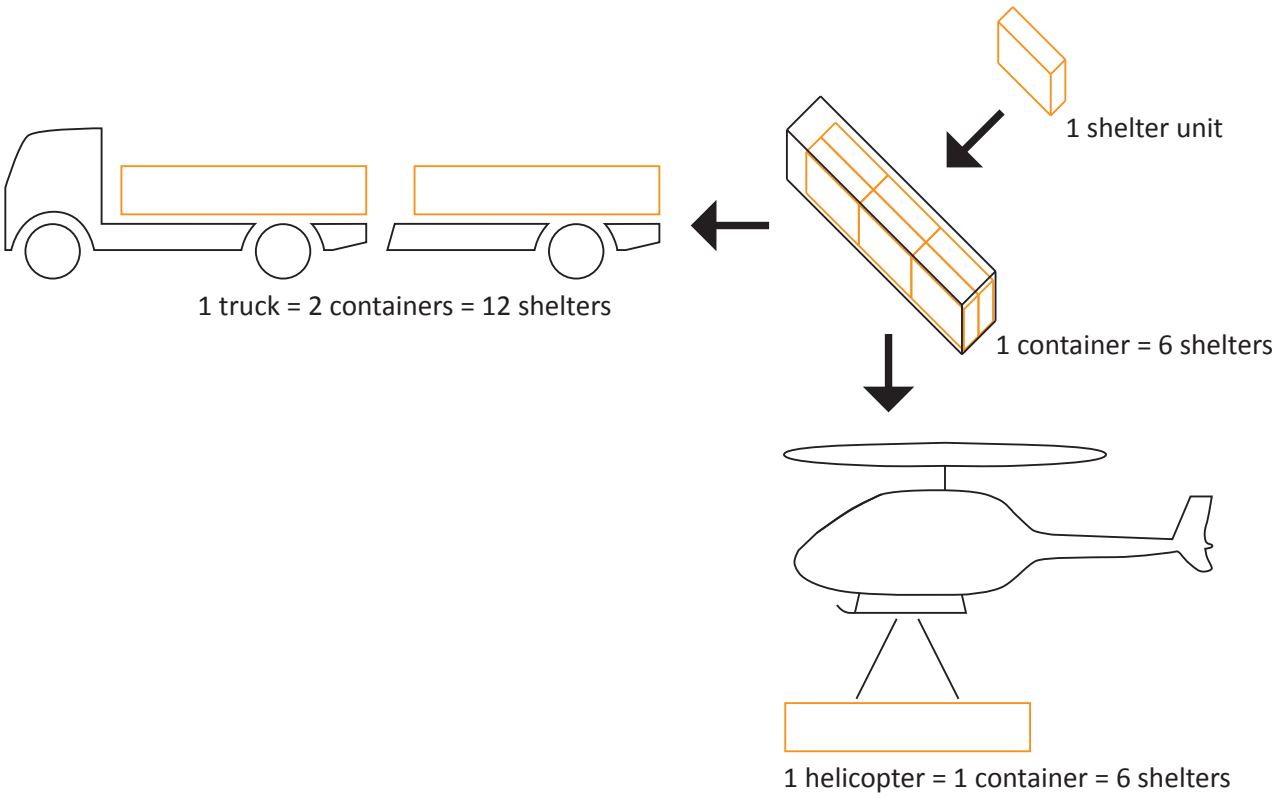


Figure 3.12 Transportation of shelters (not to scale)

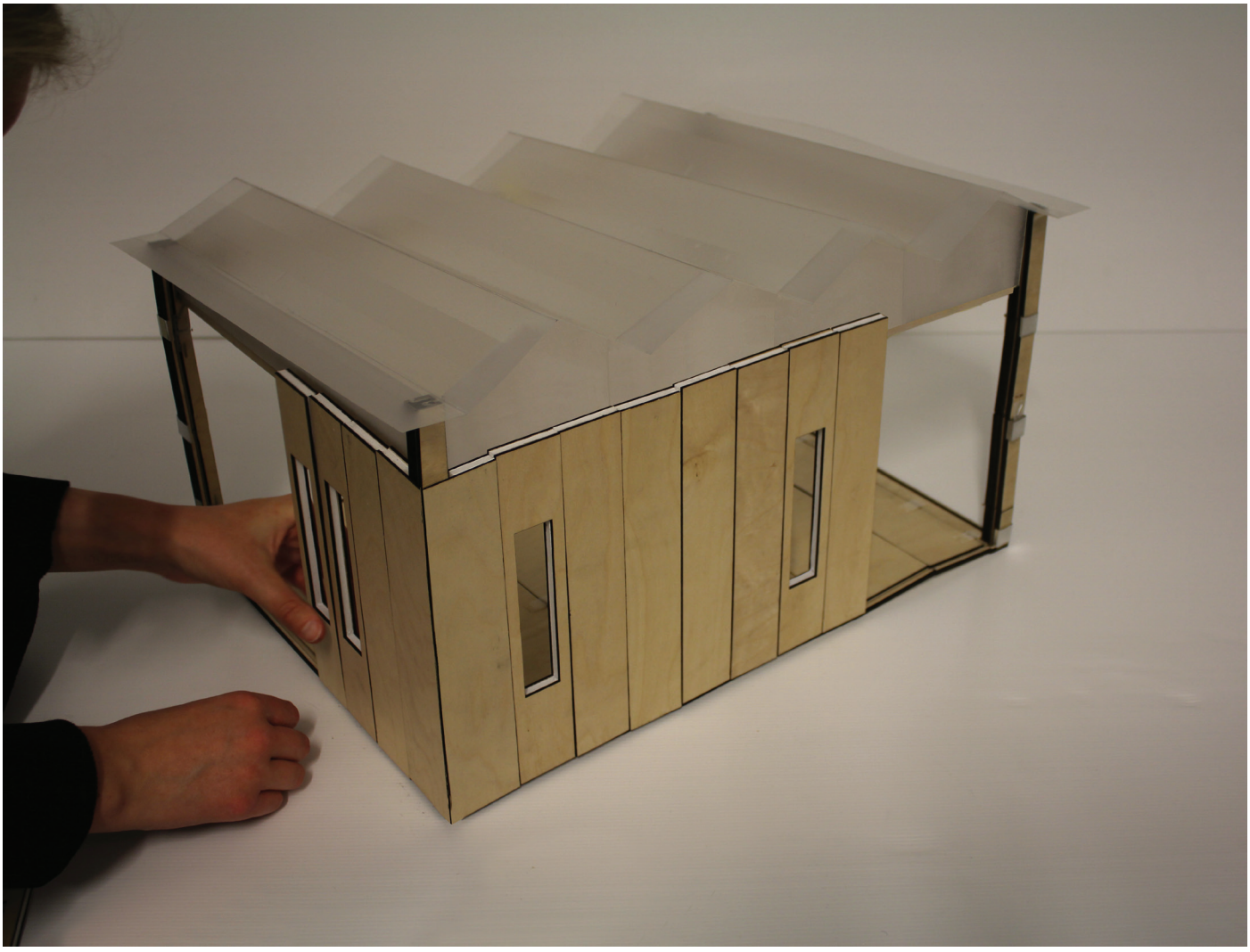


Figure 3.13 1:10 scale model being assembled

Construction

In order to test the assembly ideas, a full 1:10 model was constructed to test feasibility. Elements had already been modelled seperately, and compiling these would explore their capabilities as a shelter. The limitations were then explored through detail drawings in order to further resolve any issues.

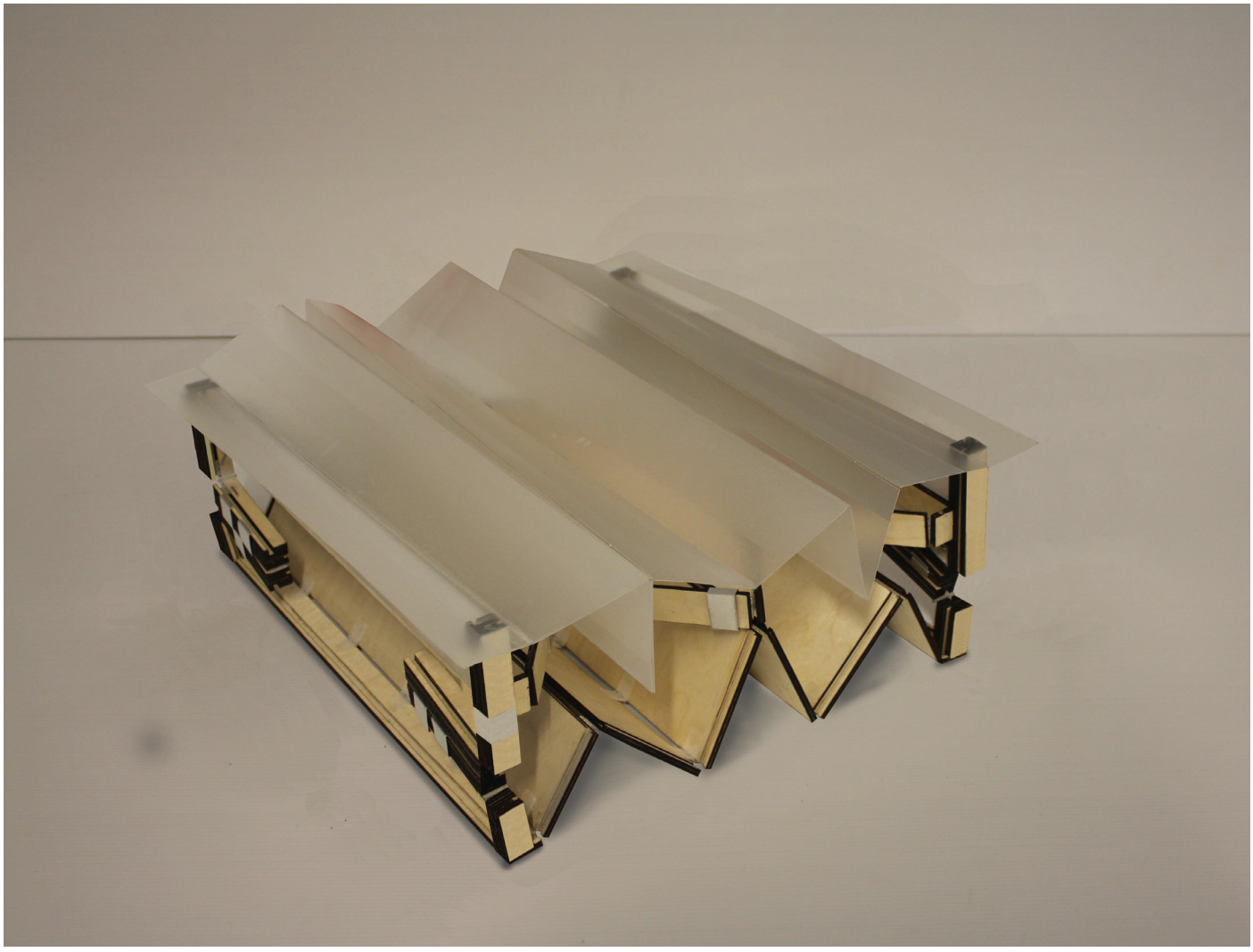


Figure 3.14 1:10 scale model - extending from the folded position outwards

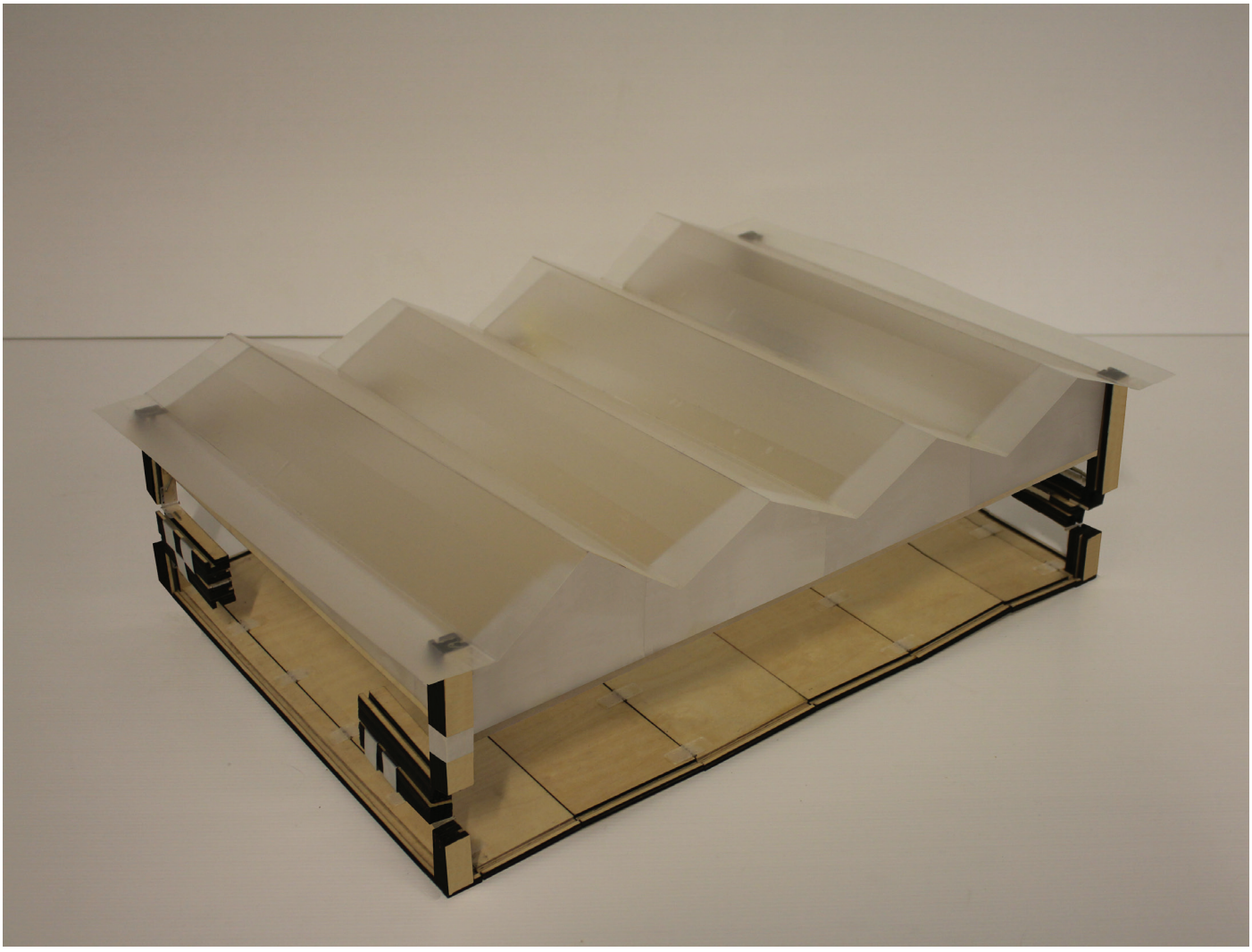


Figure 3.15 1:10 scale model - concertina floor and beams are secured and upper panels attached

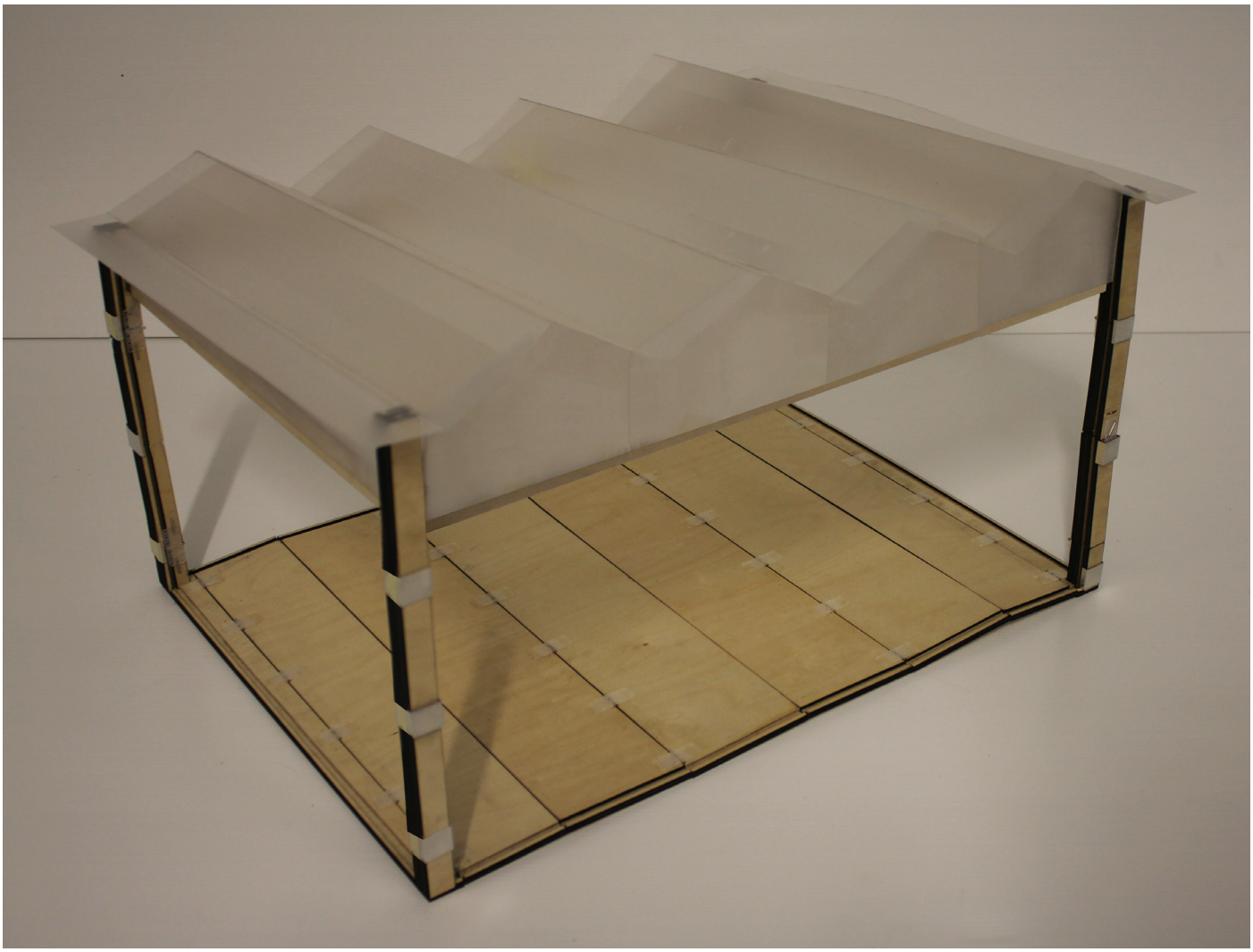


Figure 3.16 1:10 scale model - extended to full height
and column connections are secured

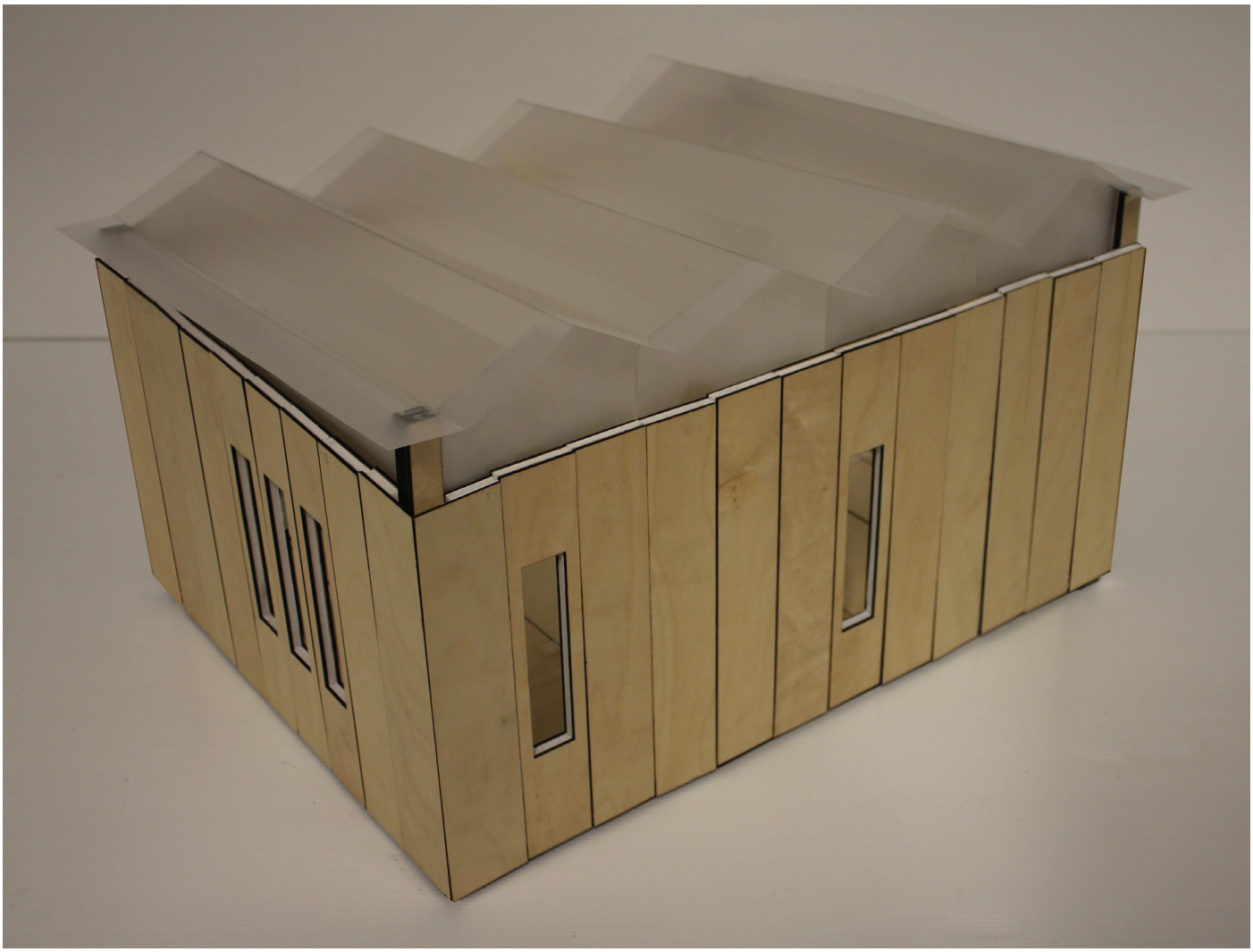


Figure 3.17 1:10 scale model - cladding panels are applied

Prefabrication methods offer a simple and cost-effective solution

Construction of the 1:10 model revealed the various limitations of the design. These were then explored through detail drawings. Limitations include:

The strength of the floor when weight is applied. Due to the concertina of the floor, the floor panels may buckle when weight is applied at particular areas. Therefore, a beam will be secured to the floor panels to ensure rigidity (refer figure 3.18). The floor will also use a continuous hinge similar to the roof (refer figure 3.19).

Waterproofing issues at the roof. A specifically designed continuous hinge will need to be used at the roof to ensure water does not enter through connection points (refer figure 3.19). Limitations in materials due to the scale of the model, resulted in the roof behaving floppy rather than rigid as it was unfolded. At 1:1, a more rigid plastic material would be used, as well as the continous hinge, to keep the roof rigid while unfolding.

A steel sleeve at the connection points in the beams was used in the model, to keep the connection point rigid and strong. This sleeve sat to the side of the connection point prior to the straightening of the beam, and was then slid into place when the beam was straightened from its concertina. At a scale of 1:10, this process worked well. However, at 1:1, the steel sleeves will need to be bolted into place to prevent them from slipping to the side again (refer figure 3.20).

In the 1:10 models, the upper panels were secured to the plywood beams, and the roof panels rested on top of the upper panels. This worked sufficiently at this smaller scale, but at 1:1 the roof panels will need to be bolted onto the upper panels (refer figure 3.21).

A steel seleeve was also used for securing the columns. The steel sleeve sat above the connection point prior to the straightening of the column, and was then slid down into place. As with the beams, this worked well at 1:10 but will require bolts to secure the sleeve at 1:1 (refer figure 3.22).

The cladding panels are held in place with grooves in the floor and columns. This was modelled at 1:10 and worked well, and has been drawn to clearly illustrate how this system works (refer figure 3.23).

The cladding panels clip onto the beam with a specifically designed clip system. During the modelling process at 1:10, the clips were attached to the beam at the same time as the cladding panels. This was because of the possibility of error of placement at such a small scale. At 1:1, one half of the clipping system will already be bolted onto the beams, and the other half of the clipping system will be bolted to the cladding panels (refer figure 3.24). The upper panel sits securely in the space between the beam and cladding panels, above the clipping system, and the roof also extends over the cladding. At 1:1, a flashing will already be connected to the upper panels, to prevent waterproofing issues (refer figure 3.24). This will then be adapted if necessary when the shelter transitions into a permanent dwelling.

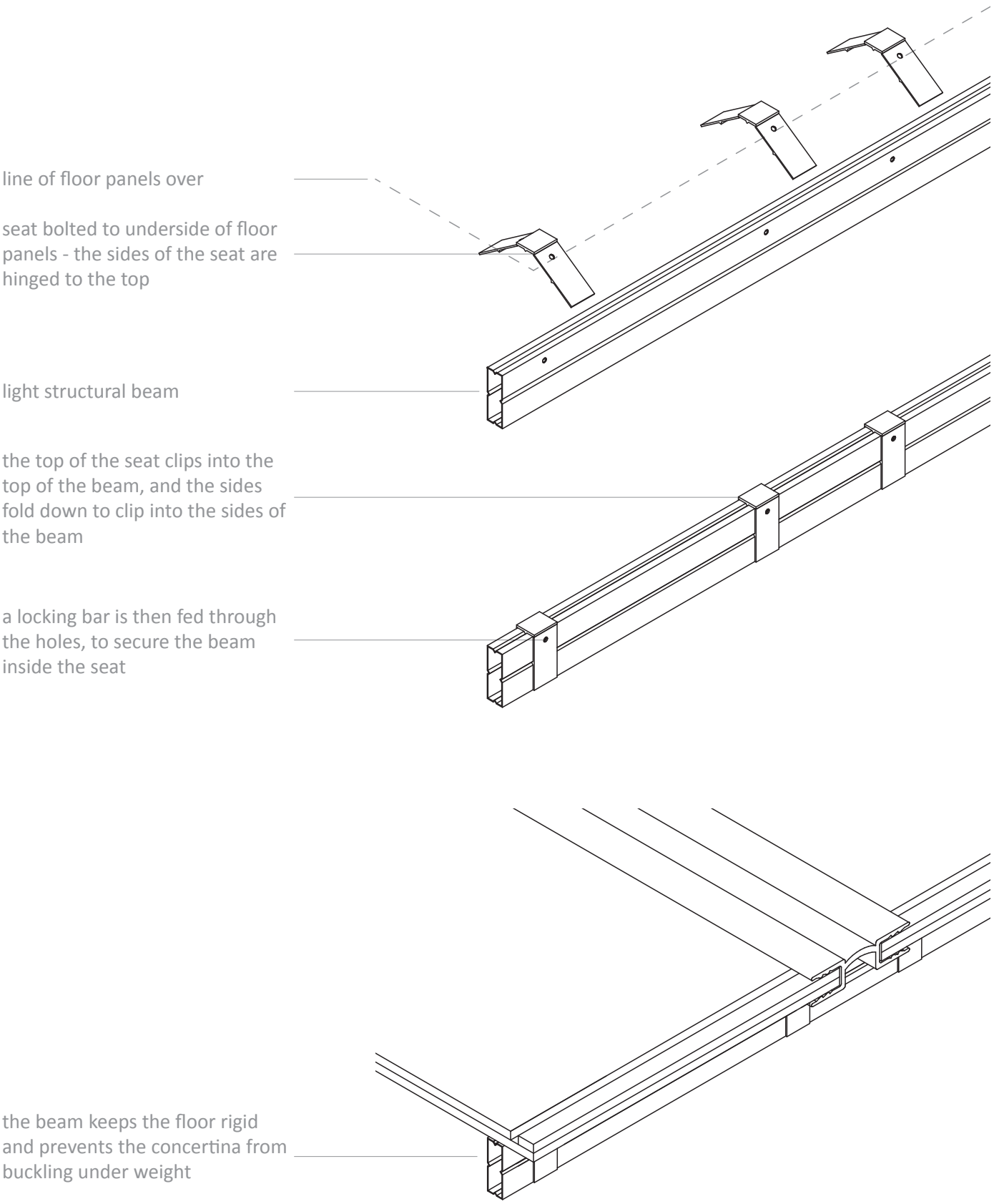


Figure 3.18 Steel support detail at floor - scale 1:10

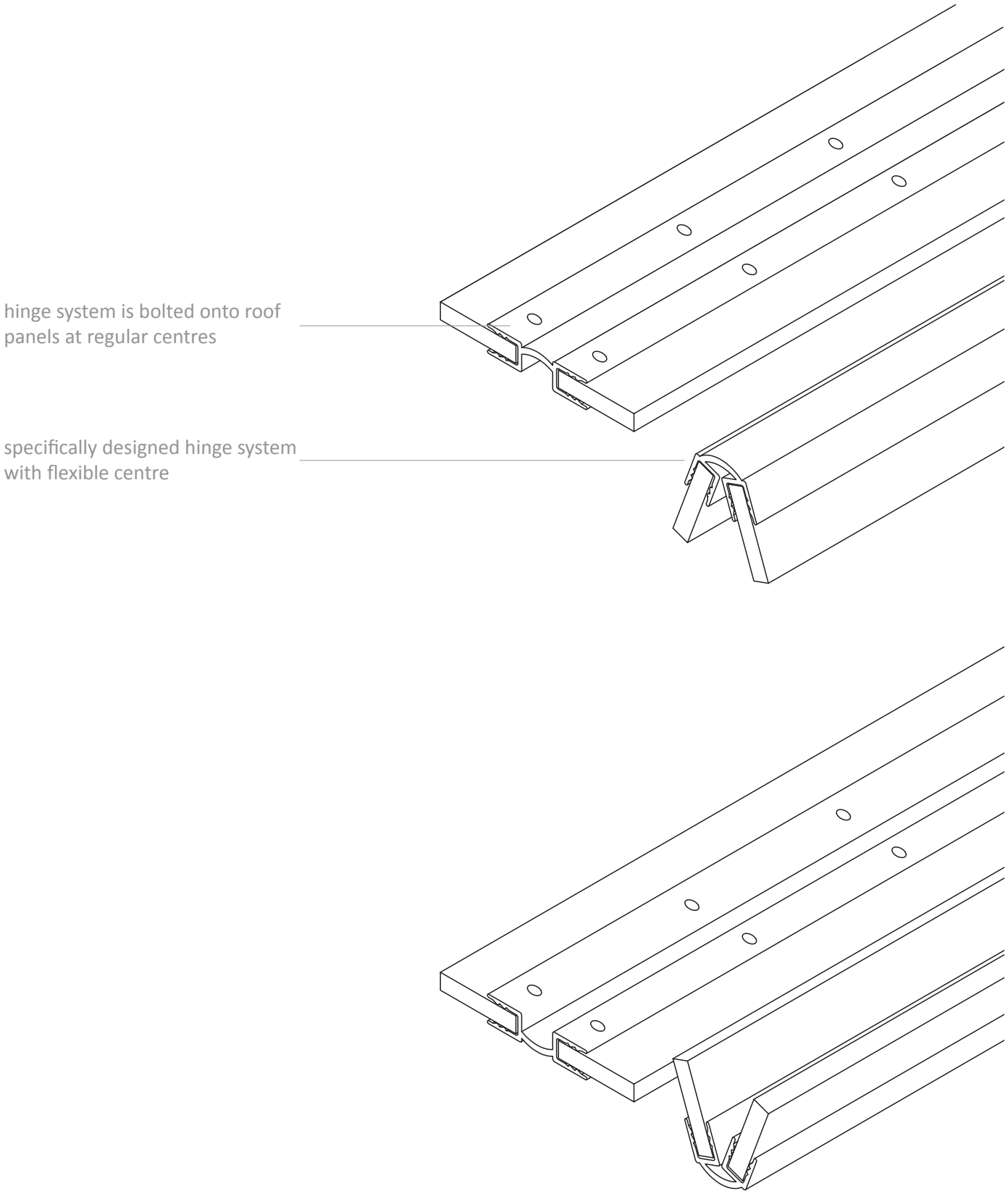


Figure 3.19 Concertina detail at roof - scale 1:10

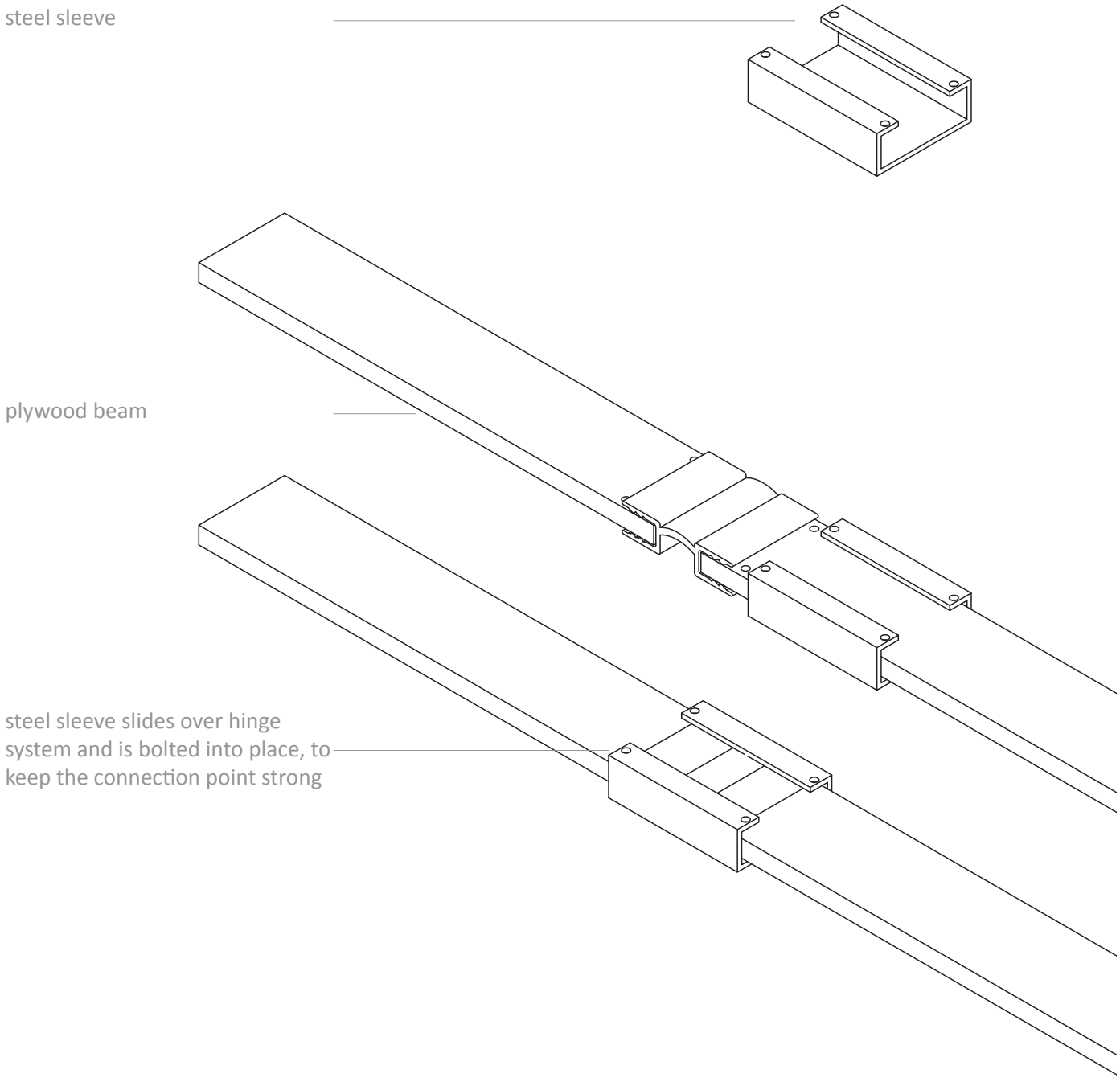


Figure 3.20 Beam connection detail - scale 1:10

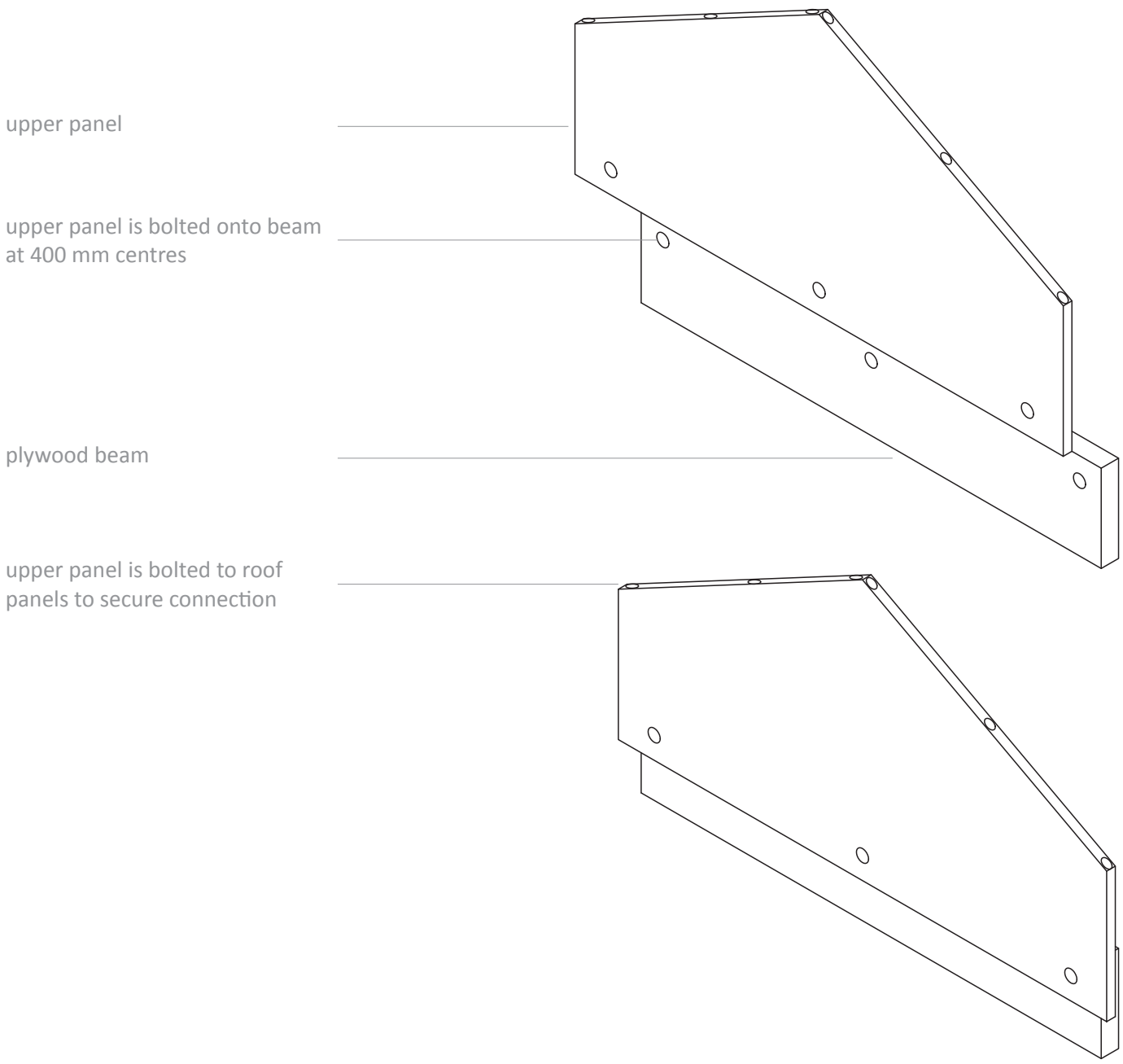


Figure 3.21 Upper panel to beam connection detail - scale 1:10

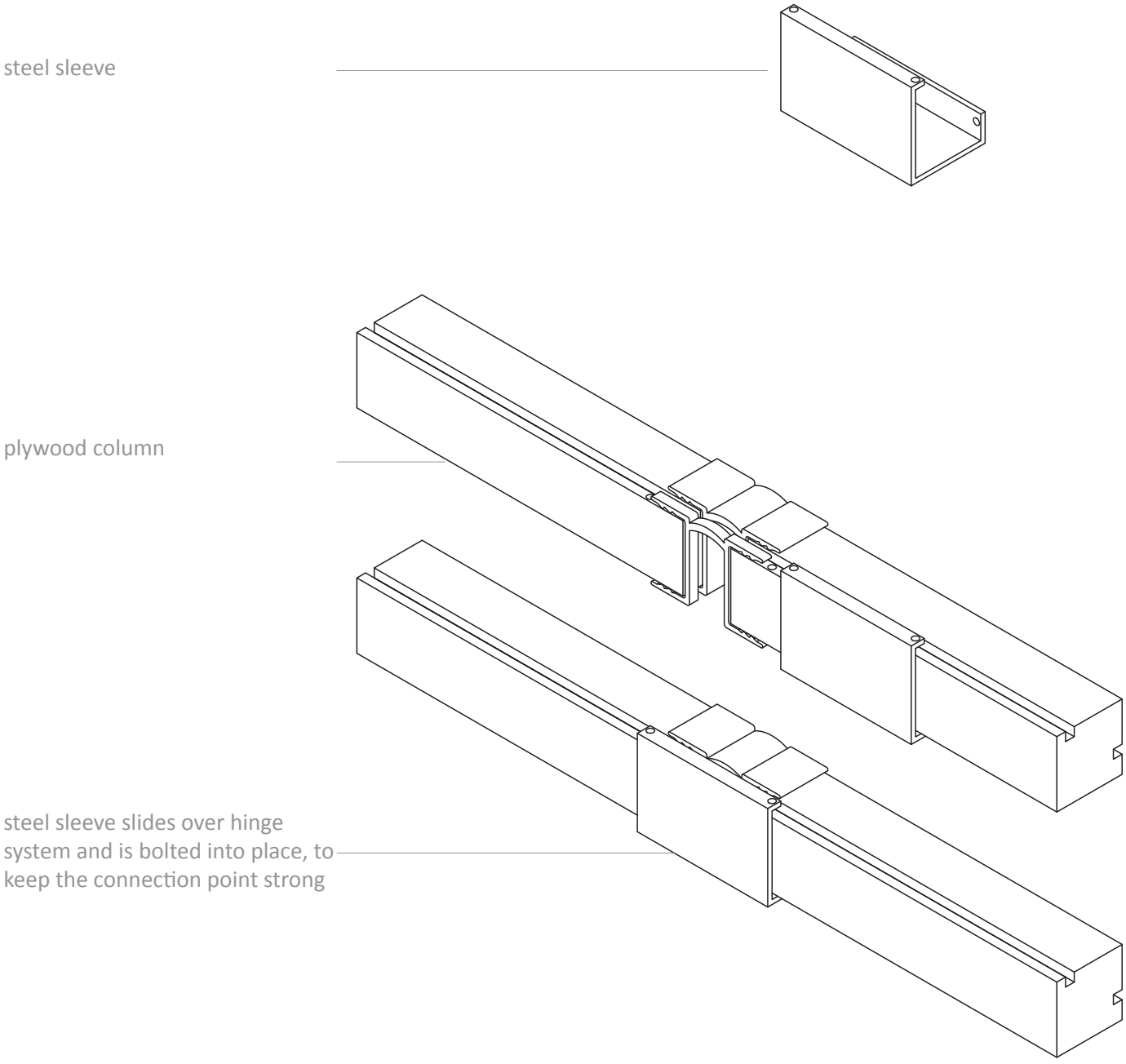


Figure 3.22 Column connection detail - scale 1:10

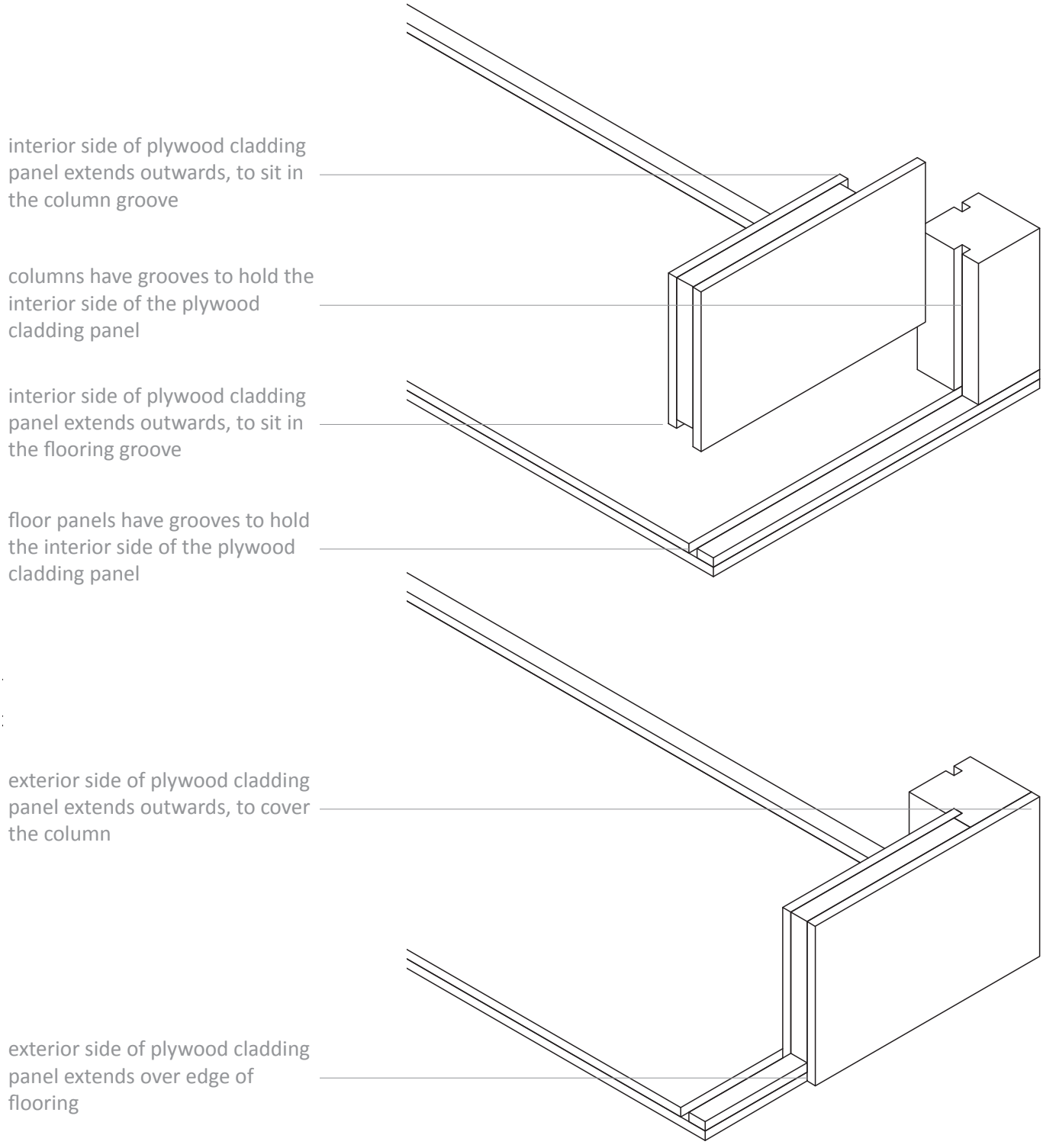


Figure 3.23 Cladding panel to floor and column connection detail - scale 1:10

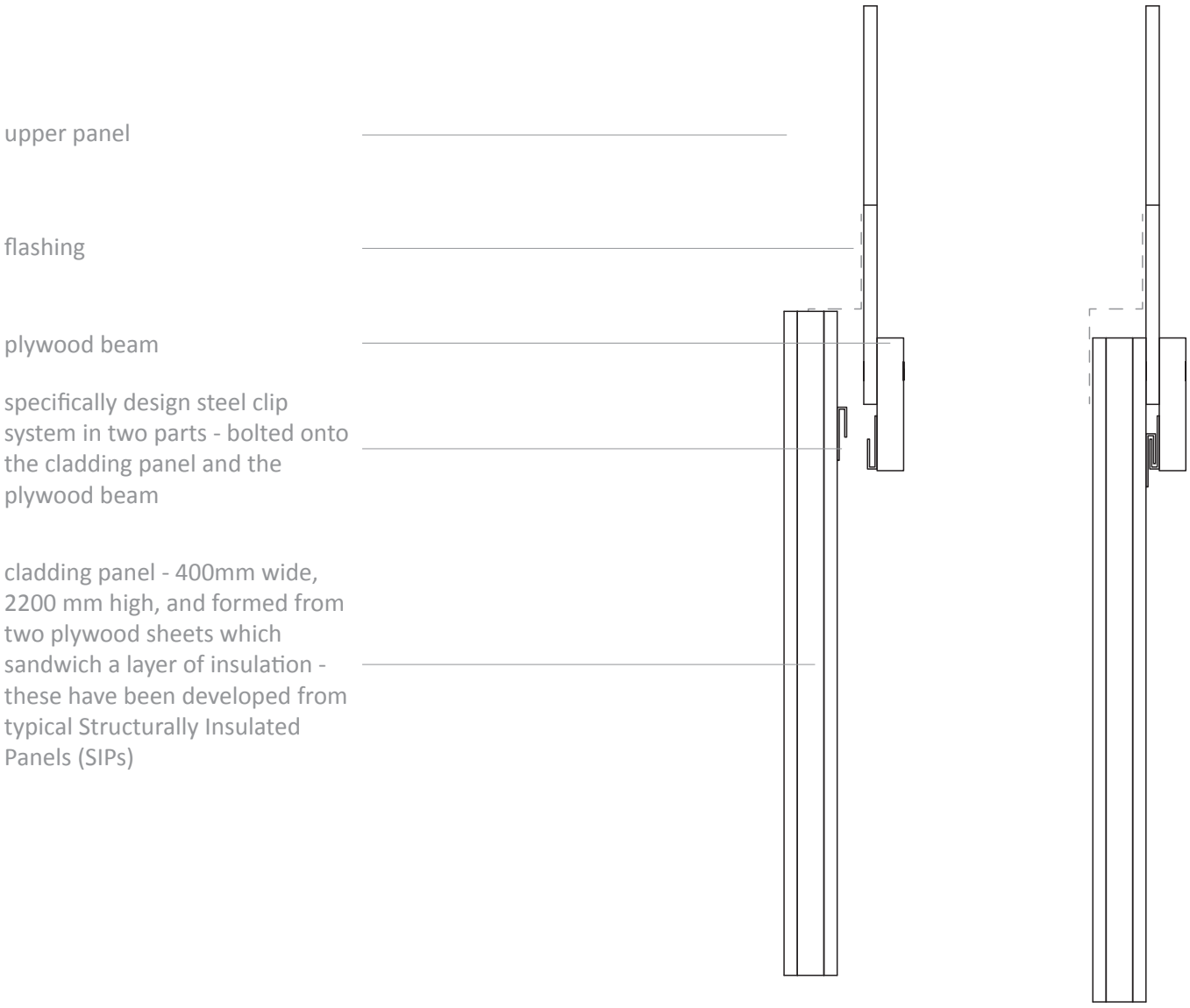


Figure 3.24 Cladding panel to beam connection detail - scale 1:10

Figure 3.25 1:10 scale model

Timeline response

Three previous housing responses after earthquakes have been studied. Three very different contexts were used - Christchurch, New Zealand (22 February 2011); Haiti (12 January 2010); and East Japan (11 March 2011). The study has highlighted the fact that even a highly organised and efficient response, such as Japan's, has significant delays in providing housing in an adequate timeframe.

This study, along with an insight into emergency housing from the literature review, prompted a new timeline which offers a quick response to housing following a disaster.

Figure 3.26 Precedent housing response timeline

purchase of 37 portable temporary accommodation units to be moved to the Riccarton Holiday Park

temporary accommodation villages extended from original life span of two years until 2016

halfway milestone for repairs - greater Christchurch's 40,000th home has been repaired

announce intent of new temporary accommodation in the central city with 2 villages of a total of 180 units intended to be resold as permanent

Rangers Park temporary accommo-dation village opened with 40 units intended to be resold as permanent

announce intent of 2 developments with a total of 450 units intended to be resold as permanent

the informal settlement of Canaan, with no services of any kind, is home to more than 40,000 people

311,196 people living in 450 displacement camps

427 camps have no on-site access to water and 228 camps have no access to toilets

60, 978 people have been forcibly evicted from 175 displacement camps

320,051 people living in 385 displacement camps, with approx 75,000 people under threat of eviction

more than 300,000 people living in temporary accommodation

98,124 people living in temporary accommodation

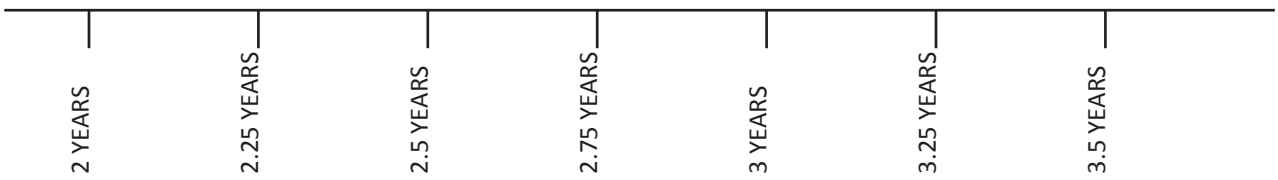


Figure 3.27 Temporary housing at the Rawhiti Domain, Christchurch, New Zealand

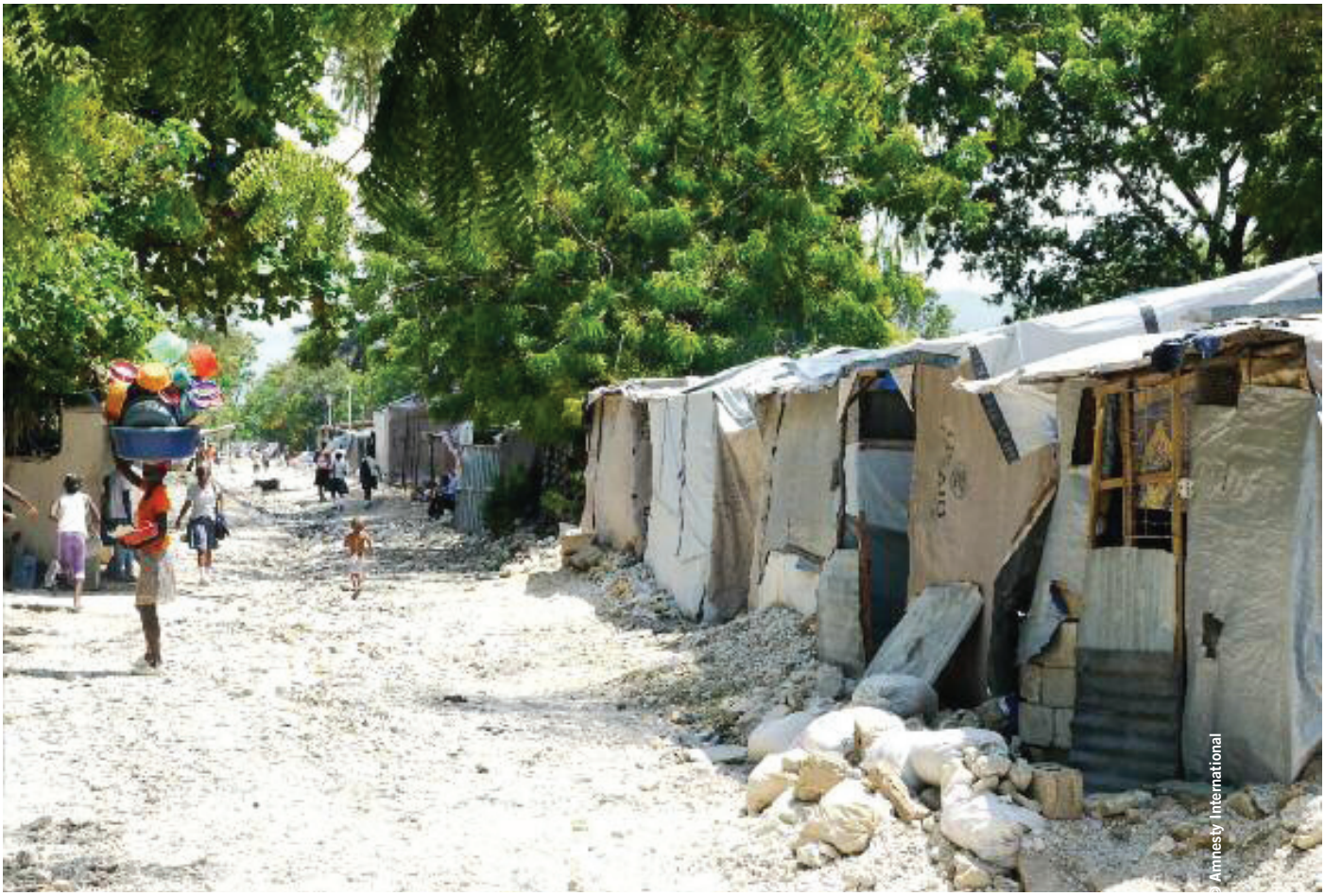


Figure 3.28 People evicted from their camps have set up shelters outside Camp Grace Village, Carrefour municipality, Port-au-Prince, Haiti. Source: Amnesty International, “Nowhere to go”.

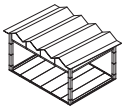
Figure 3.29 The Asutonagamachi temporary housing units in Sendai, Miyagi Prefecture, Japan. Source: Bloomberg, “Japan’s Quake Survivors”.

Figure 3.30 (Facing Page) Proposed housing response timeline. The proposed timeline of the transitional house proposes that the initial shelter is in storage within New Zealand so that it can be deployed immediately, and that a permanent dwelling is completed within a year.

The temporary shelter transitions into a permanent dwelling

DAY OF DISASTER

initial shelter structure deployed (cladding deployed with structure or soon after)

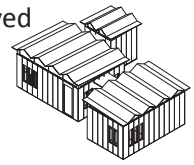


kitchen panels deployed

1 MONTH

bathroom module deployed

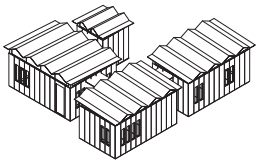
additional modules deployed



2 MONTHS

3 MONTHS

additional modules deployed as necessary



4 MONTHS

5 MONTHS

6 MONTHS

7 MONTHS

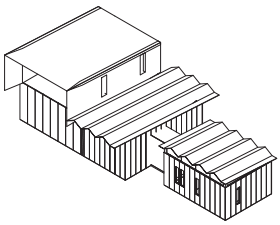
8 MONTHS

9 MONTHS

10 MONTHS

11 MONTHS

1 YEAR



permanent dwelling complete

Day of disaster

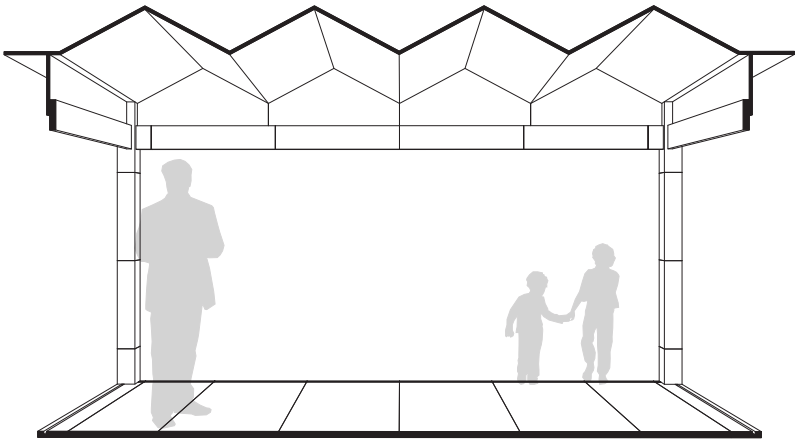
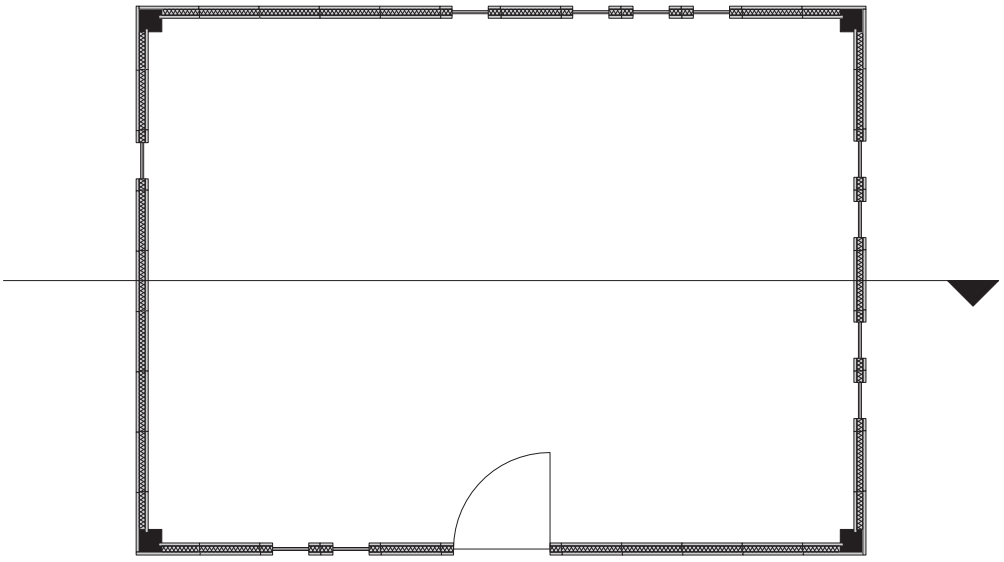


Figure 3.31 Plan and section at 1:50. Depending on the scale of the disaster and its impact, initial shelters may be deployed without cladding, in order to ensure the arrival of basic shelter for everyone.

One - two days



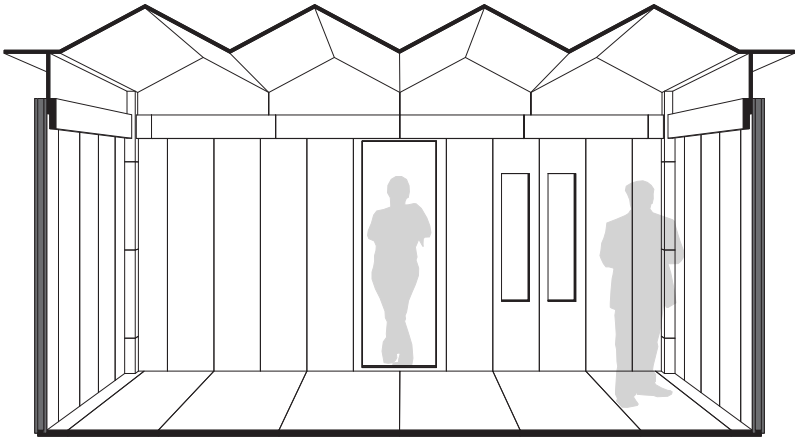
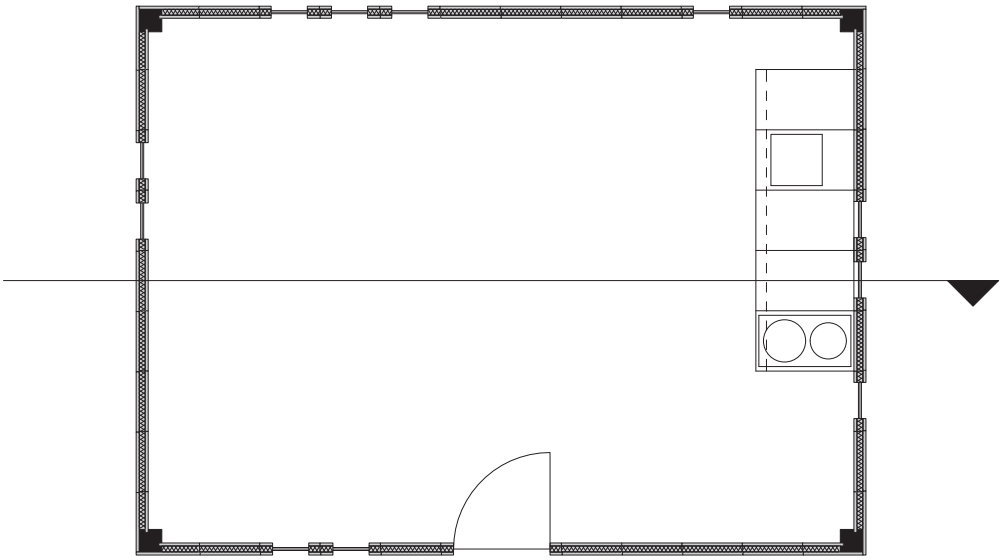


Figure 3.32 Plan and section at 1:50. Depending on the scale of the disaster and its impact, cladding may arrive alongside the initial shelter structure, or be deployed within two days. The cladding panels are removable and interchangeable with each other (with the exception of the corner panels), in order for openings to respond to context appropriately.

Two - three weeks



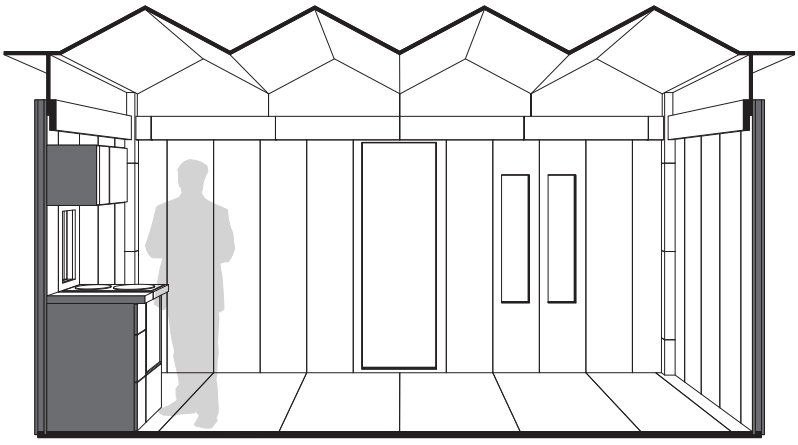


Figure 3.33 Plan and section at 1:50. Kitchen cabinetry are built into structural cladding panels, and can replace the cladding panels within the transitional house. They can be rearranged in various configurations, at any point within the house. Additional kitchen panels can also be brought in at a later date if desired.

Two - four weeks

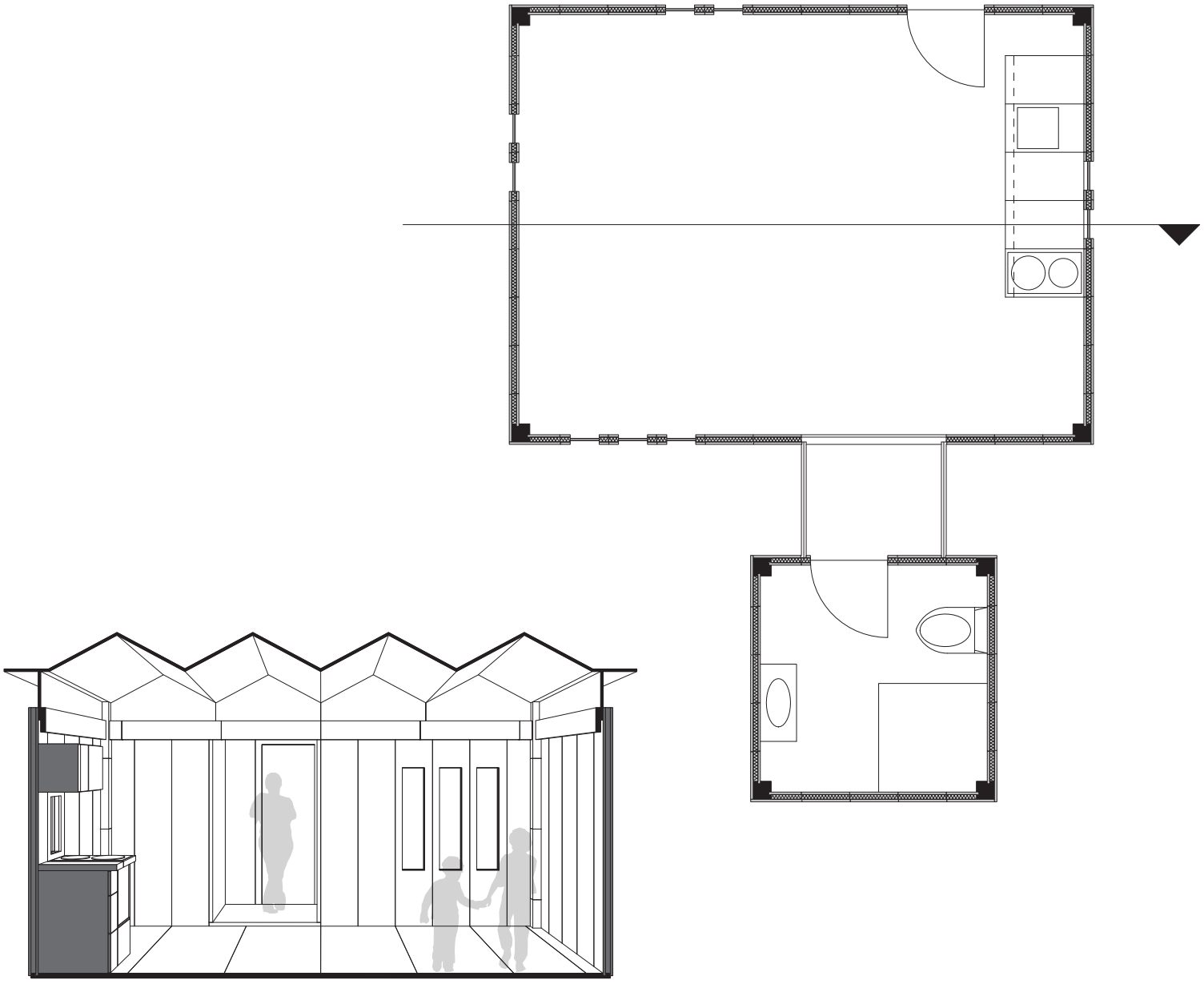


Figure 3.34 Plan and section at 1:50. The bathroom module is attached to the transitional house via a linking module. This linking module replaces three cladding panels. With a lowered ceiling height, it plugs into the transitional house, creating a passage way without doubling up on walls. The same system is used for all additional modules.

Prior to the arrival of the bathroom module, people will use publicly available facilities. After the Christchurch earthquake, the use of portaloos were widely successful - the eventual issues lay in the length of time the portaloos were in use for. In the timeline for the transitional house the portaloos will only be in use until the bathroom module can arrive.

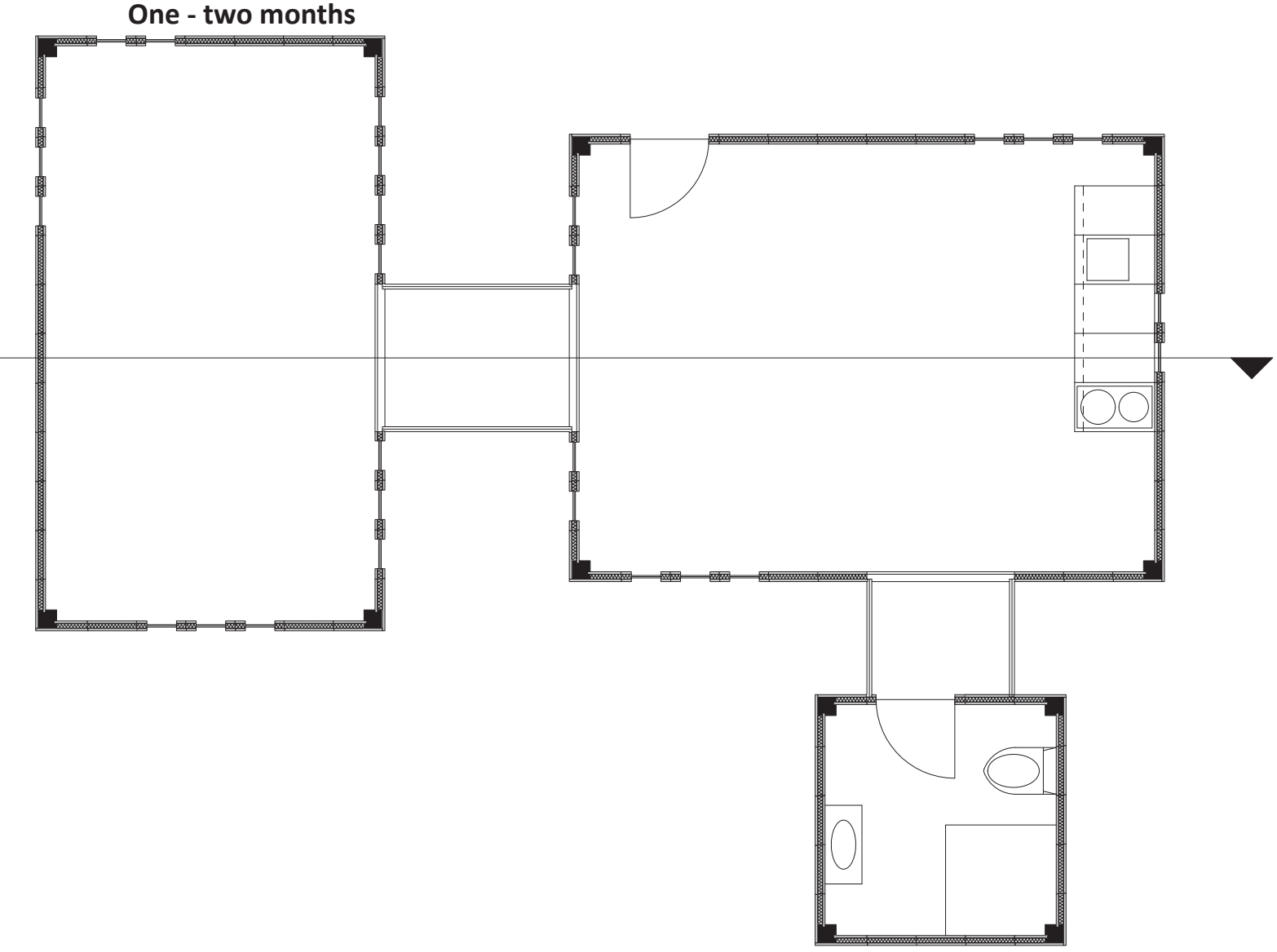


Figure 3.35 Plan at 1:50. Additional modules begin to be deployed, in order to create independent spaces within the transitional house. Additional modules are attached via linking modules, and can be arranged in various configurations around the initial shelter.

Figure 3.36 Section at 1:50. Additional modules use the same cladding system as the initial shelter, so that panels continue to be interchangeable throughout the house. This also means that additional modules can grow off each other, using the same linking module system.

Three - four months

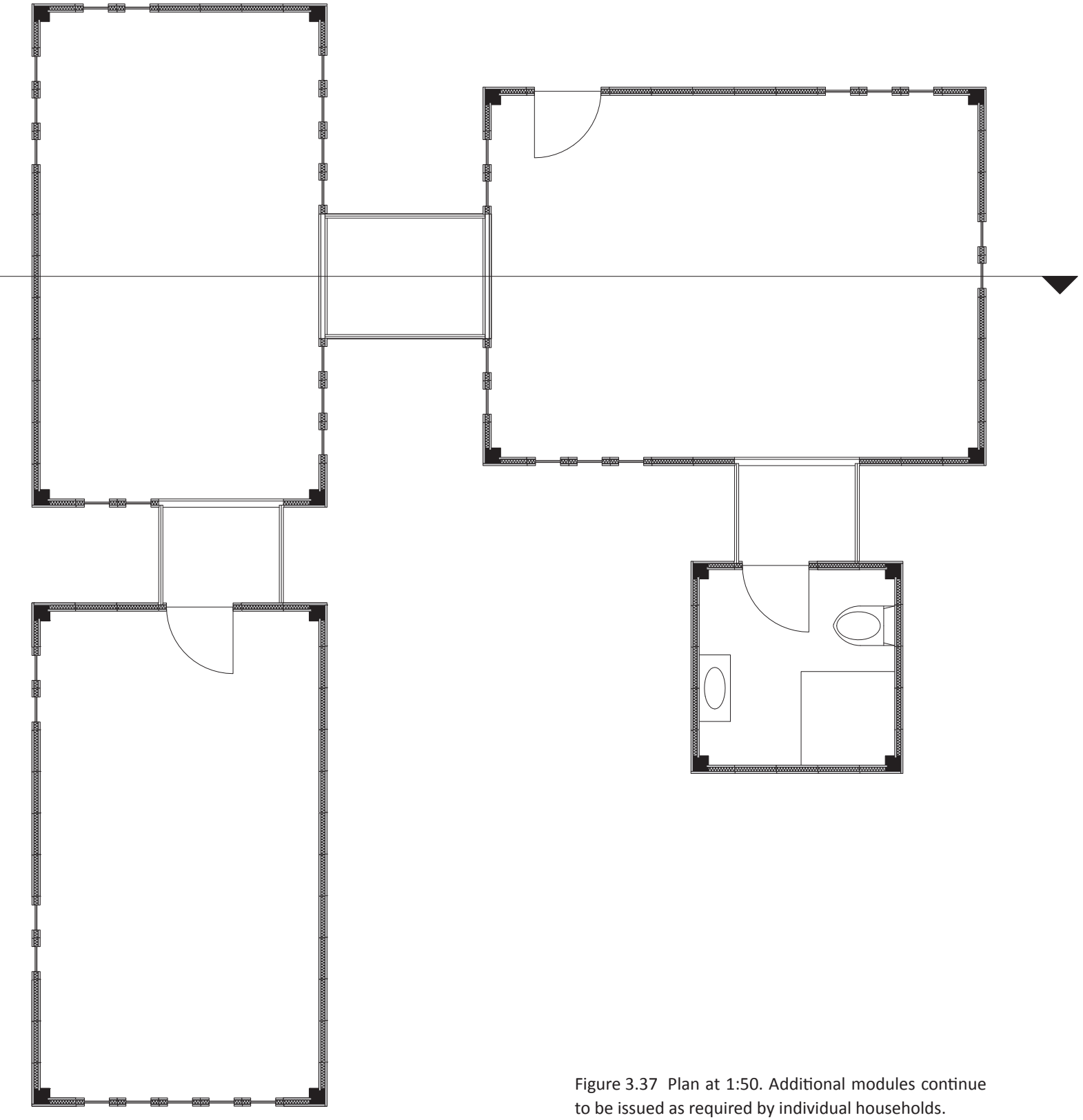


Figure 3.37 Plan at 1:50. Additional modules continue to be issued as required by individual households.

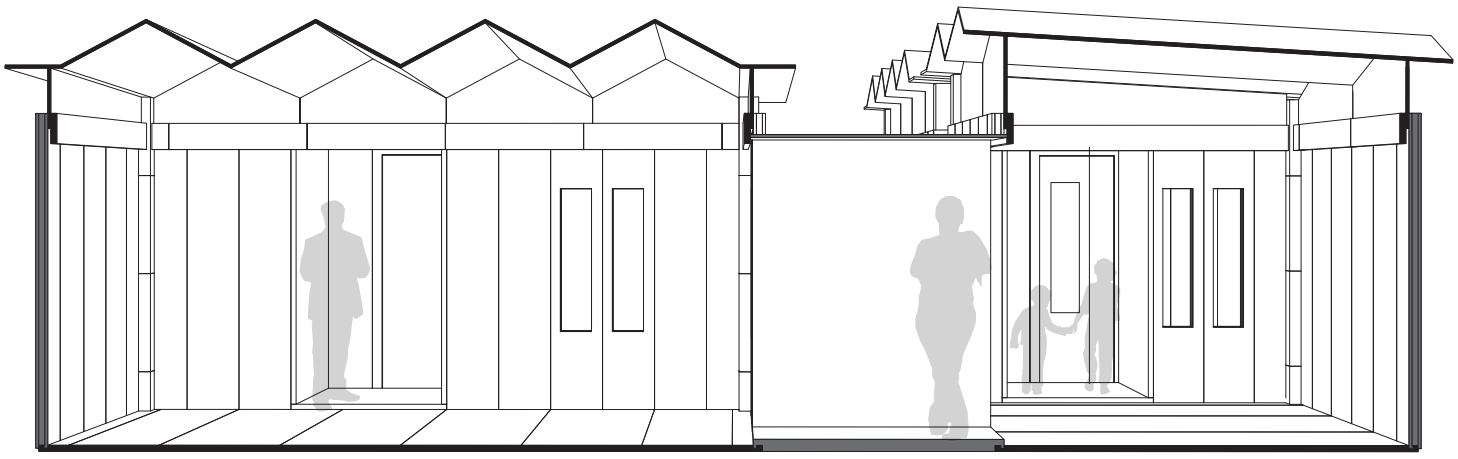


Figure 3.38 Section at 1:50. At this stage, additional modules can be ordered in different sizes, both in plan and height, in order to better suit the occupants and the site.

Twelve months

The transitional house is now a permanent dwelling - however it can continue to adapt as the needs of the occupants change. The permanent condition will vary between occupants, and may be a combination of the initial shelter, and new individual elements. In these combinations, particular elements of the initial shelter may influence the new designs - such as the linking modules, or removable cladding panels.

Site specific design

This design section tests the design in specific conditions throughout Wellington. Four sites have been selected for their contextual differences. These sites are used to test how the transitional house might occupy different sites.

The land in the first site, located in Ngaio, becomes very steep almost directly behind the existing house.

The second location is in Hataitai, where the site is situated on the edge of a cliff.

The third site is located in the inner-residential suburb of Mt Cook. Here the density is higher than in the other three sites, resulting in a high site coverage.

The fourth site, in Karori, has a large amount of relatively flat land to the rear of the building.

By necessity, the initial shelter modules are often located where there is room. However, as it transitions into a permanent dwelling, it seeks to reference the existing house typologies in the area.

96 Awarua Street, Ngaio, Wellington

96 Awarua Street is a 1960s single-storey family home, clad in brick. The land is relatively flat at the front, and becomes steep behind the house. The house has a gable roof and a small garage is attached to the side. This is consistent down Awarua Street. The houses are generally stepped back from the street by 2-4 metres. This is likely due to the steep land at the rear of the properties making the back half of the sites difficult to occupy.

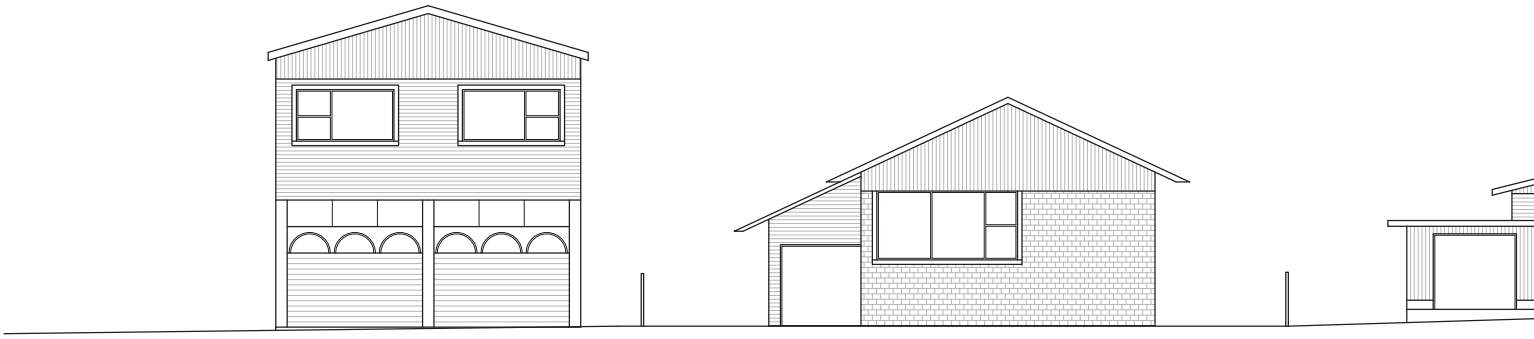


Figure 3.39 Awarua Street elevation - 1:200

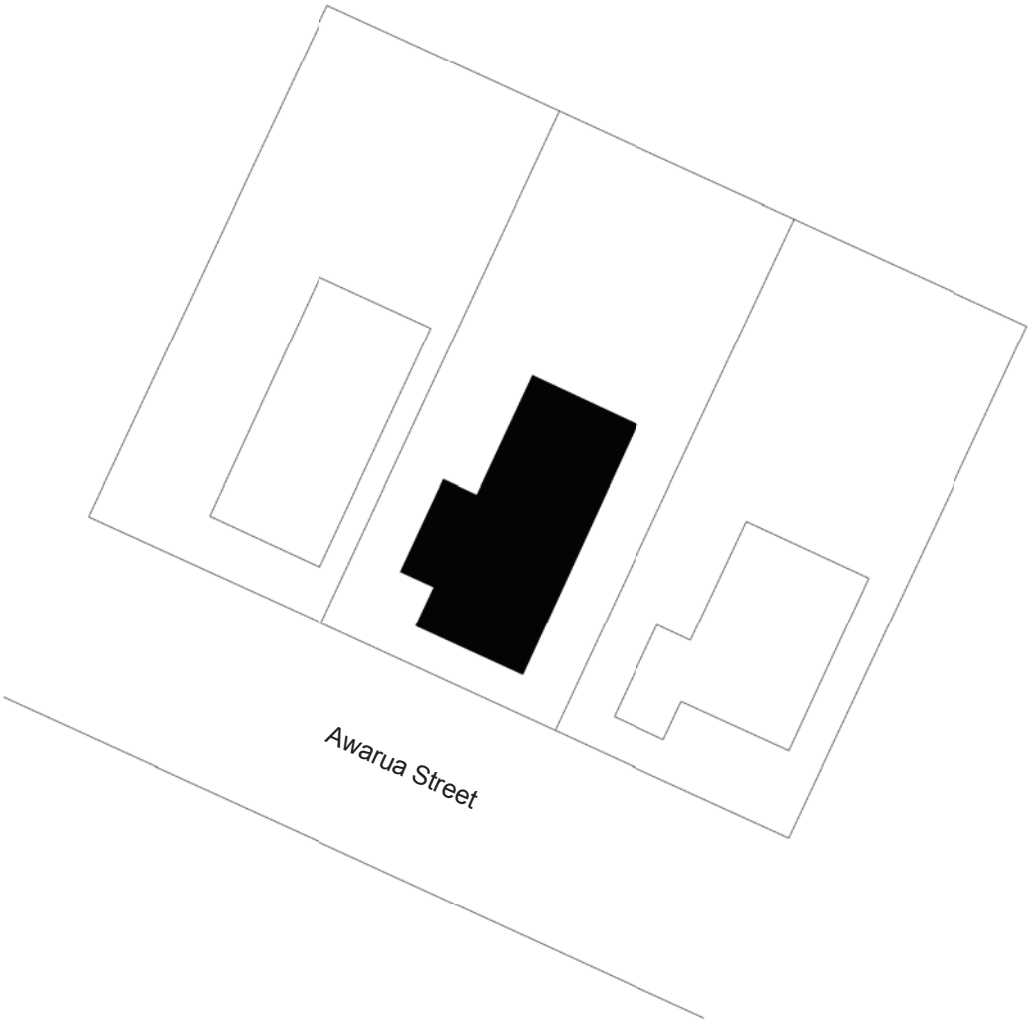


Figure 3.40 Awarua Street plan - 1:500

Figure 3.41 Day of a major earthquake. The transitional shelter is located behind the garage, to the left of the house.

Figure 3.42 1 month post-disaster. The location of the transitional shelter is on the largest area of flat land on the site, however there is only room for the initial shelter and a bathroom module.

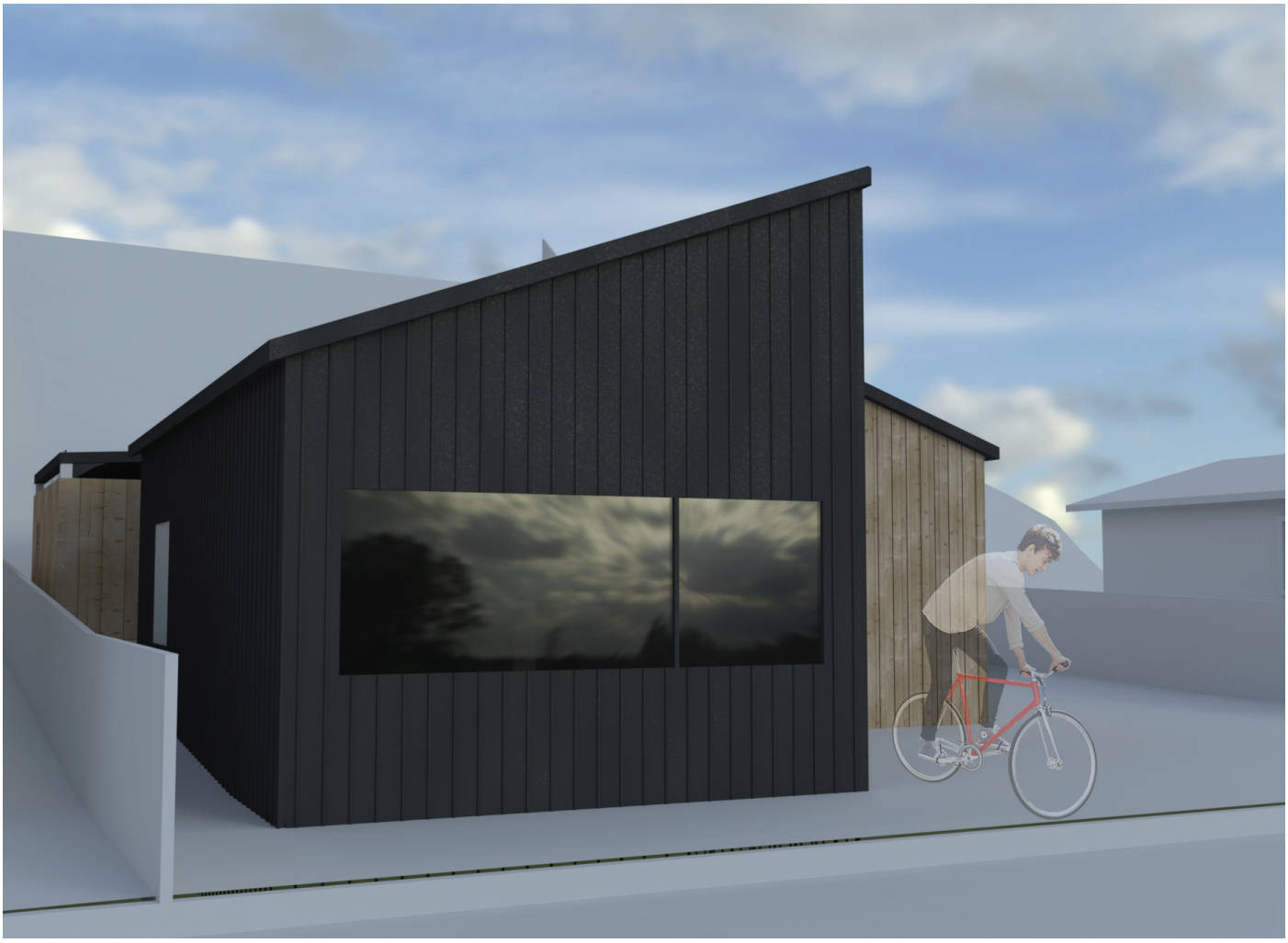


Figure 3.43 12 months post-disaster. The damaged house has been demolished. The initial shelters are still in place, but with a new roof and new cladding panels. New modules extend towards the front of the site. These have been designed with a new aesthetic, referencing the gable roofs which are common down Awarua Street.

Figure 3.44 12 months post-disaster. A linking module is used to link the initial shelters into the new modules.

21B Treasure Grove, Hataitai, Wellington

21A and 21B Treasure Grove are two storey family houses, built in the late 1980s. It is common to have two houses on a single site in Treasure Grove and many of these multiple dwellings are identical. 21A and 21B Treasure Grove share a party wall down the centre and are almost identical at the exterior. The interior configurations differ, and 21B extends slightly further to the rear. Treasure Grove is located along a cliff edge, looking over the water. As such, the back half of the sections are almost impossible to occupy, but offer beautiful views over the harbour. The houses in Treasure Grove are of an eclectic style, and difficulty lies in attempting to establish a typology.

Figure 3.45 Treasure Grove elevation - 1:200

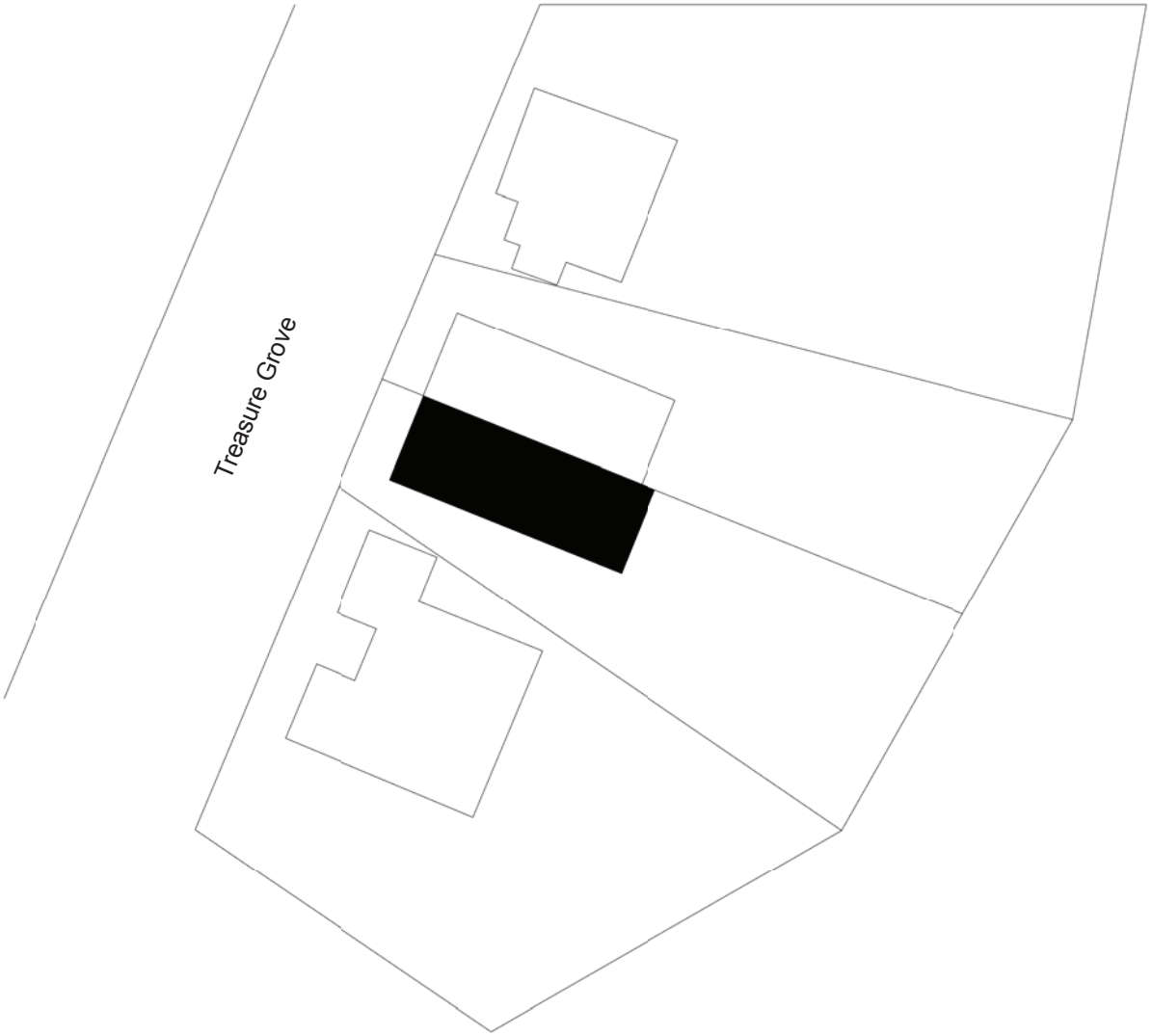


Figure 3.46 Treasure Grove plan - 1:500

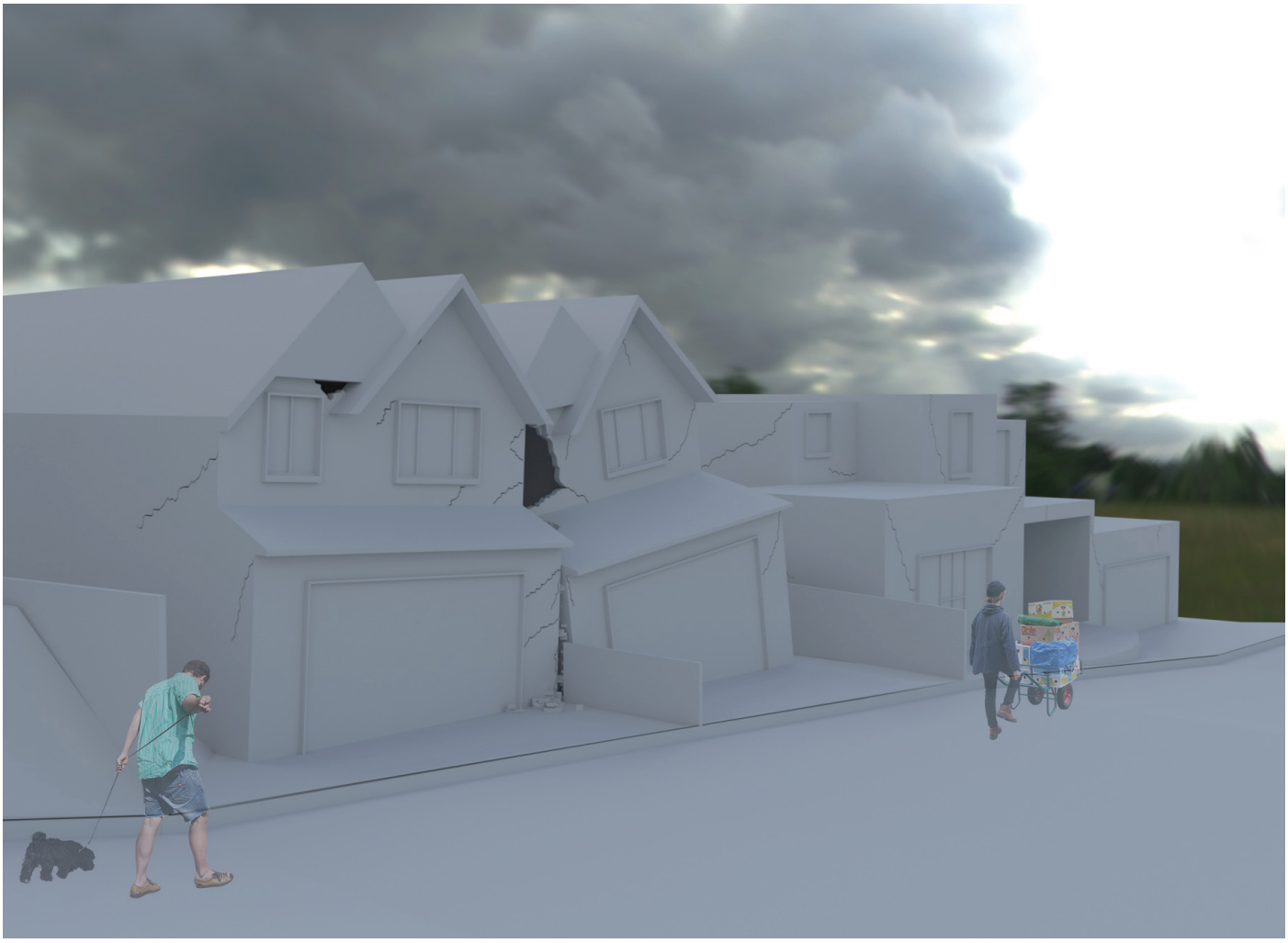


Figure 3.47 Day of a major earthquake. The transitional shelter is unable to be located on site, due to the lack of available land.

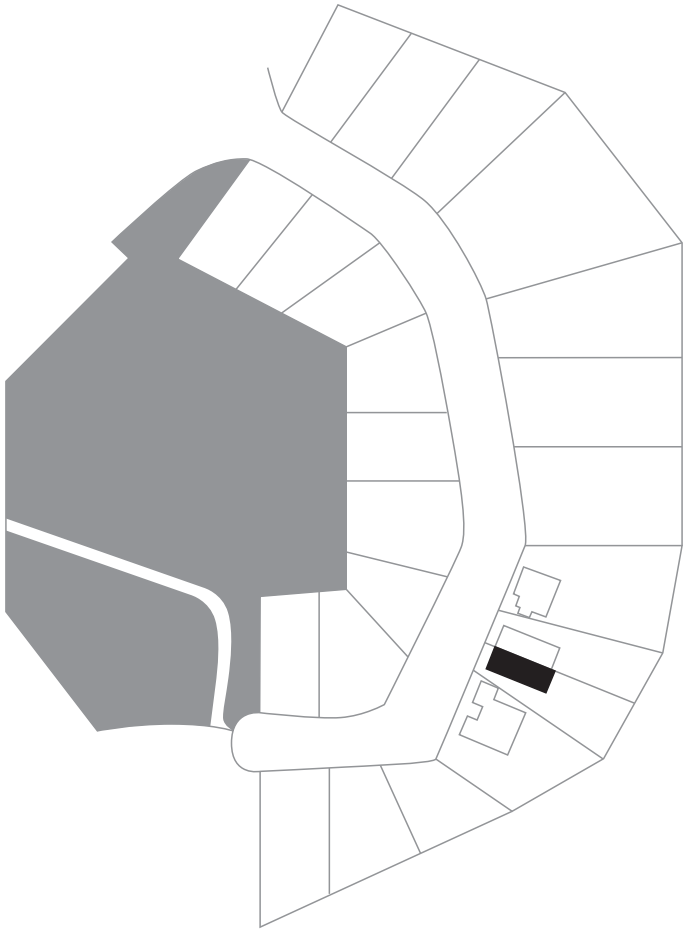


Figure 3.48 Plan - scale 1:2000. Where individuals' own land is unable to be occupied, the transitional house will be located at a nearby community park - such as this one at the end of Treasure Grove.

Figure 3.49 The transitional house is temporarily located at a community park. Each household is allocated a small amount of land, in which to expand their transitional house with additional modules as necessary.

Figure 3.50 The transitional shelters of 21A and 21B are shown here at the community park. The shelters are able to be disassembled and packed back down to their original transportation size, for relocation.

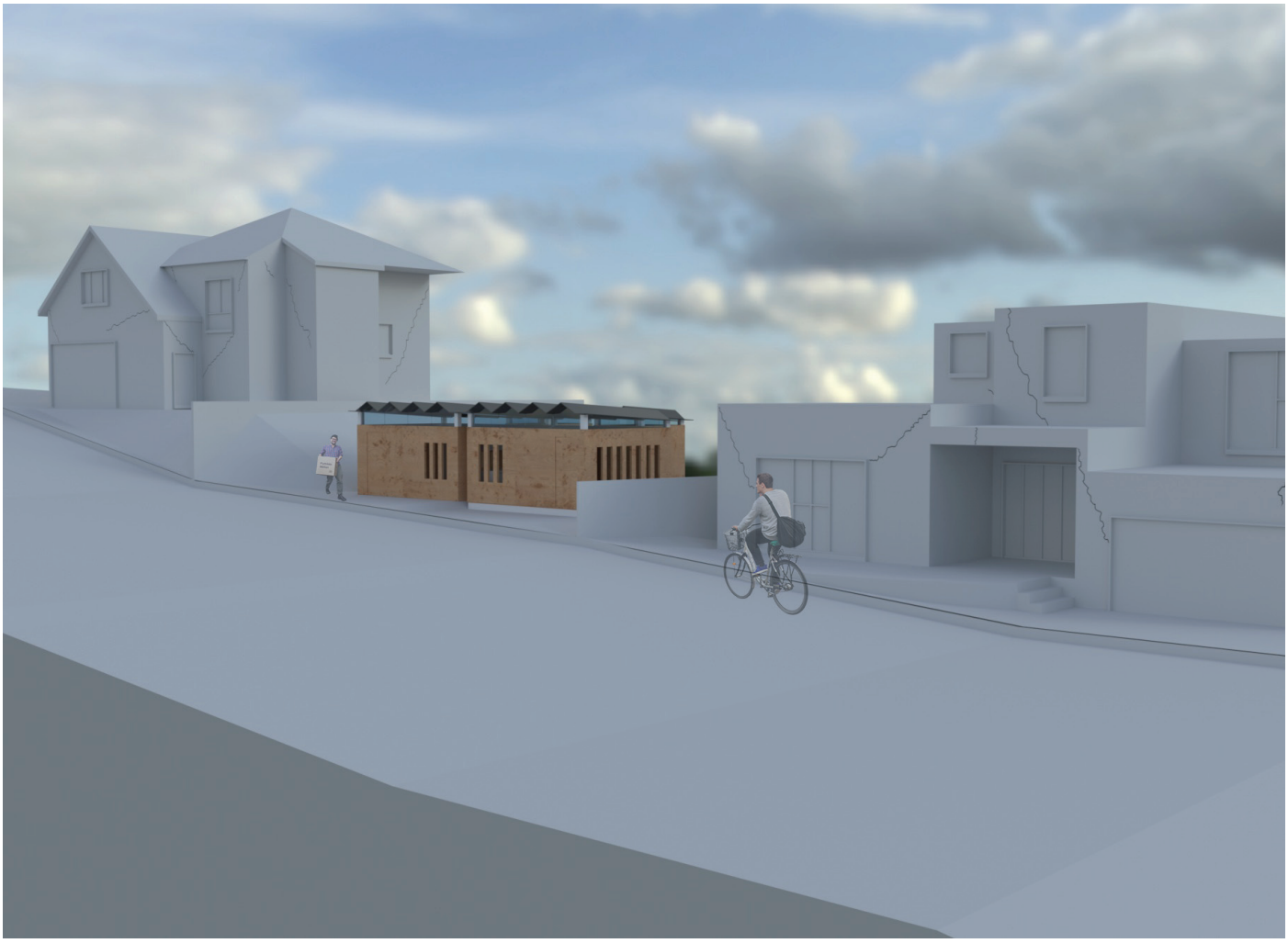


Figure 3.51 6 months post-disaster. After the damaged houses have been demolished, the transitional shelters can move back onto individuals' own land.

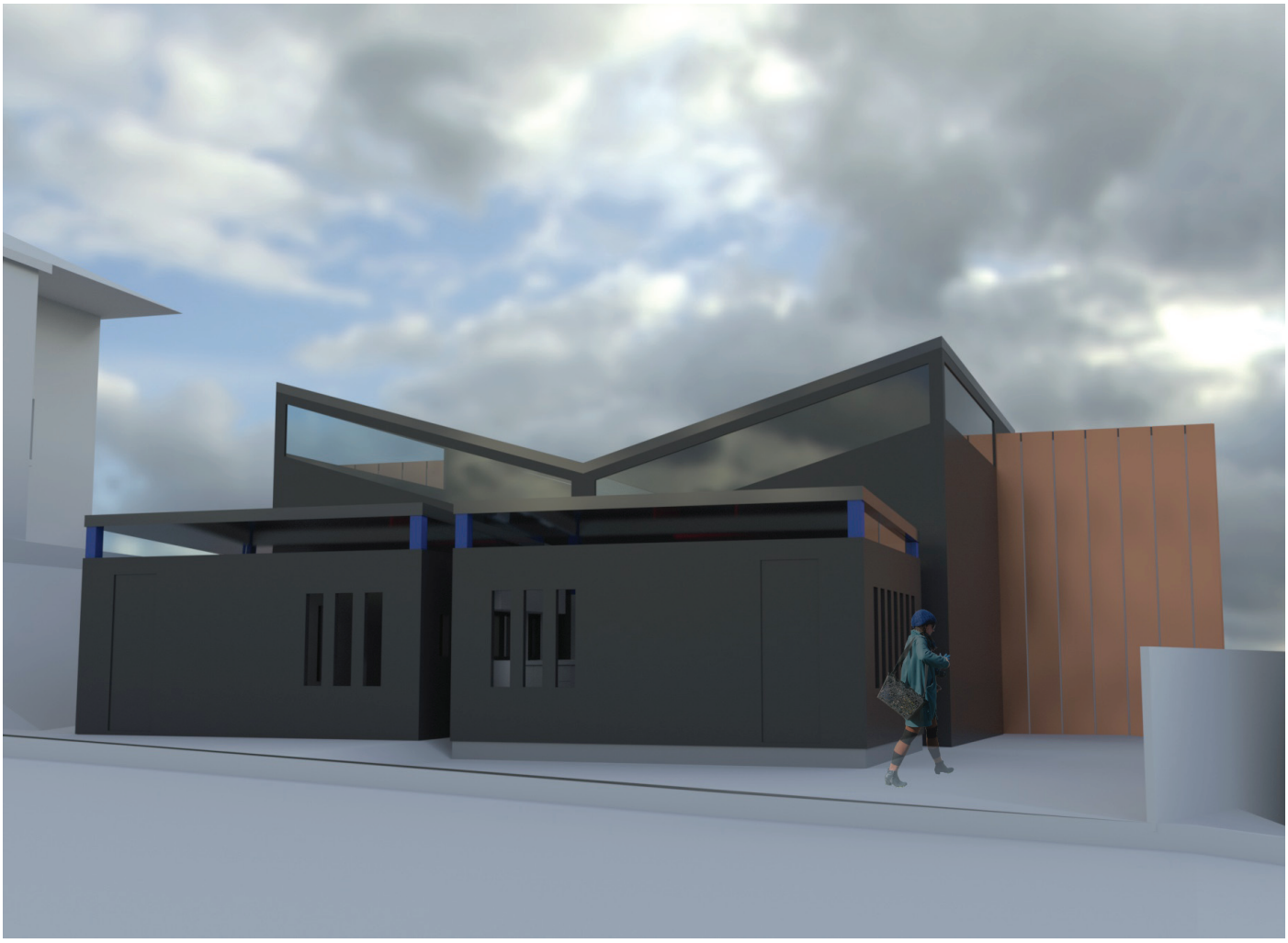


Figure 3.52 12 months post-disaster. The transitional shelters are still in place, and have been adapted with permanent elements. New modules have been designed behind the initial shelters, connected via a linking module. 21A and 21B Treasure Grove mirror each other on site, maintaining the symmetry of the original houses pre-disaster.

58B Wallace Street, Mt Cook, Wellington

58B Wallace Street is an infill house, built in 2008. 58 Wallace Street is a sprawling house built in the 1960s, which covers the majority of the site. However, due to the steepness of the site, the house is barely noticeable from the street. The other houses on Wallace Street are located at the street edge, resulting in an active street front. 58B was designed to be sympathetic with its neighbours, and has a garage at the street level and three storeys above. As the neighbours are only three storey buildings, the third floor of 58B Wallace Street has been stepped back from the rest of the street, and aligns itself with 58 Wallace Street.

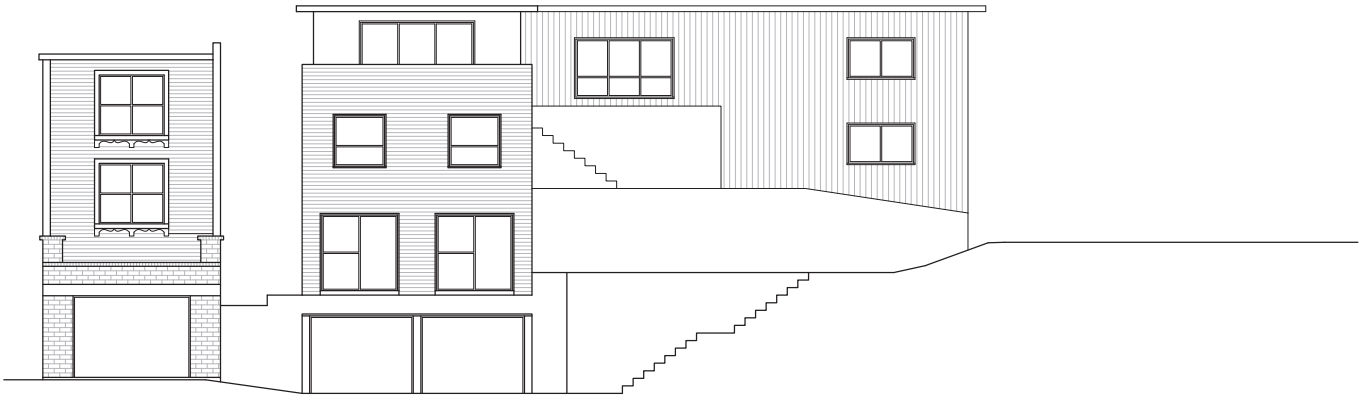


Figure 3.53 Wallace Street elevation - 1:200

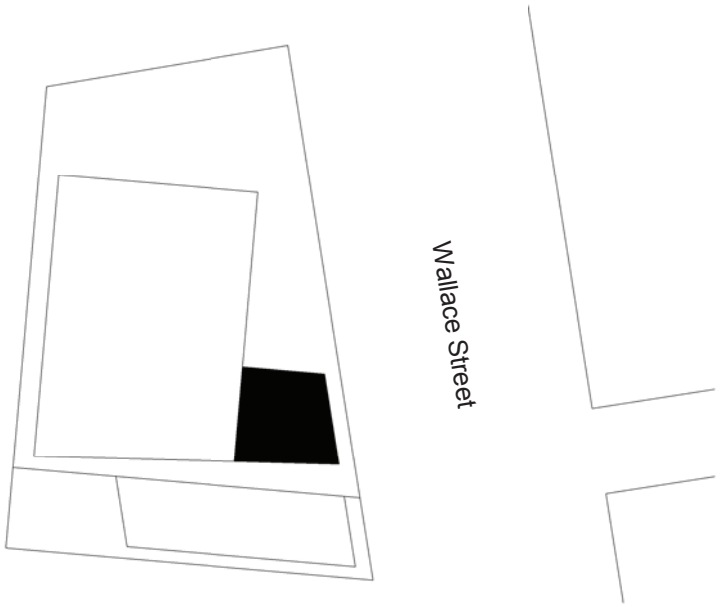


Figure 3.54 Wallace Street plan - 1:500

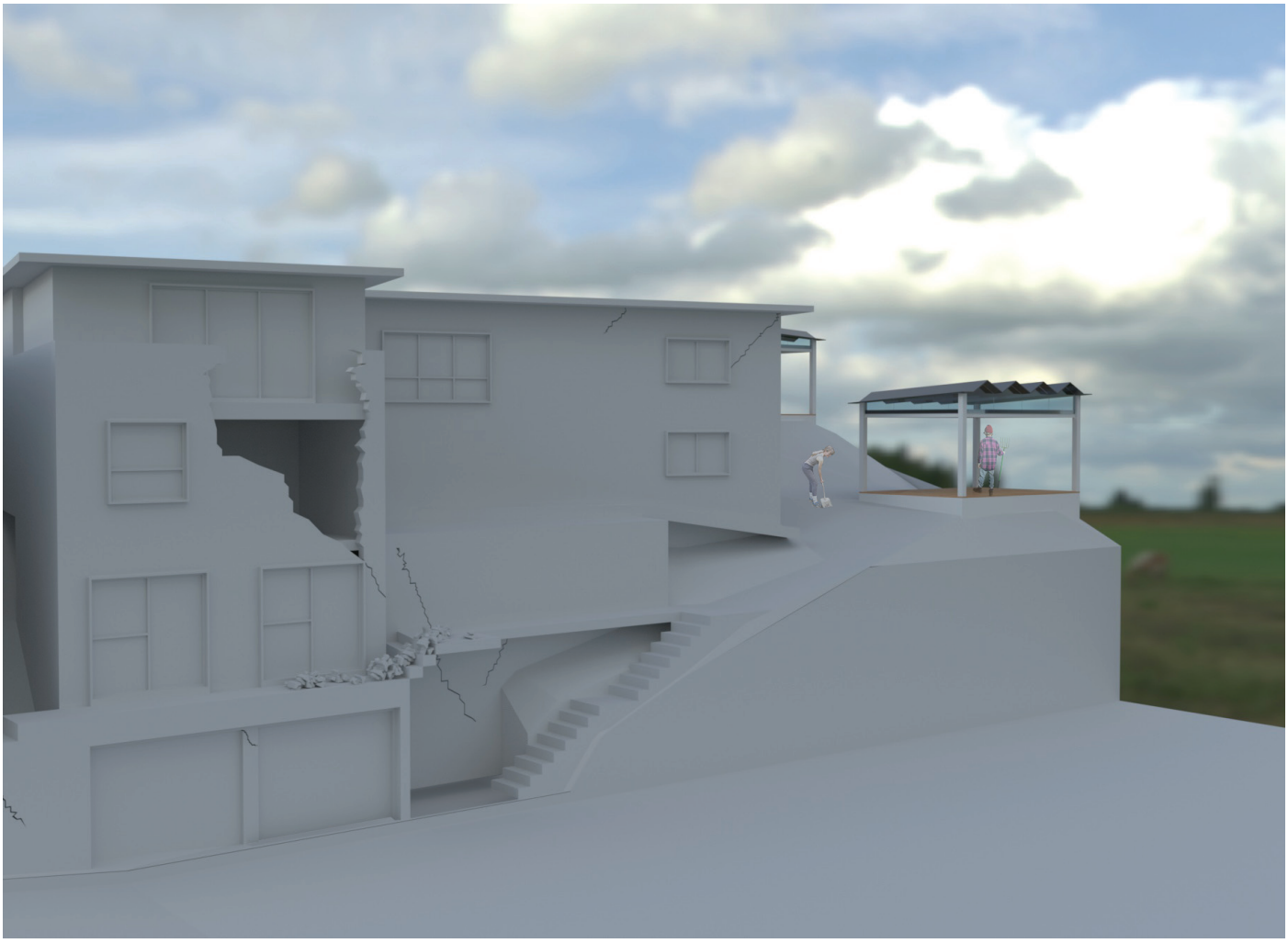


Figure 3.55 Day of a major earthquake. The transitional shelter is deployed without cladding panels, due to the volume of shelters required. As there are two houses on site, two shelters have been provided.

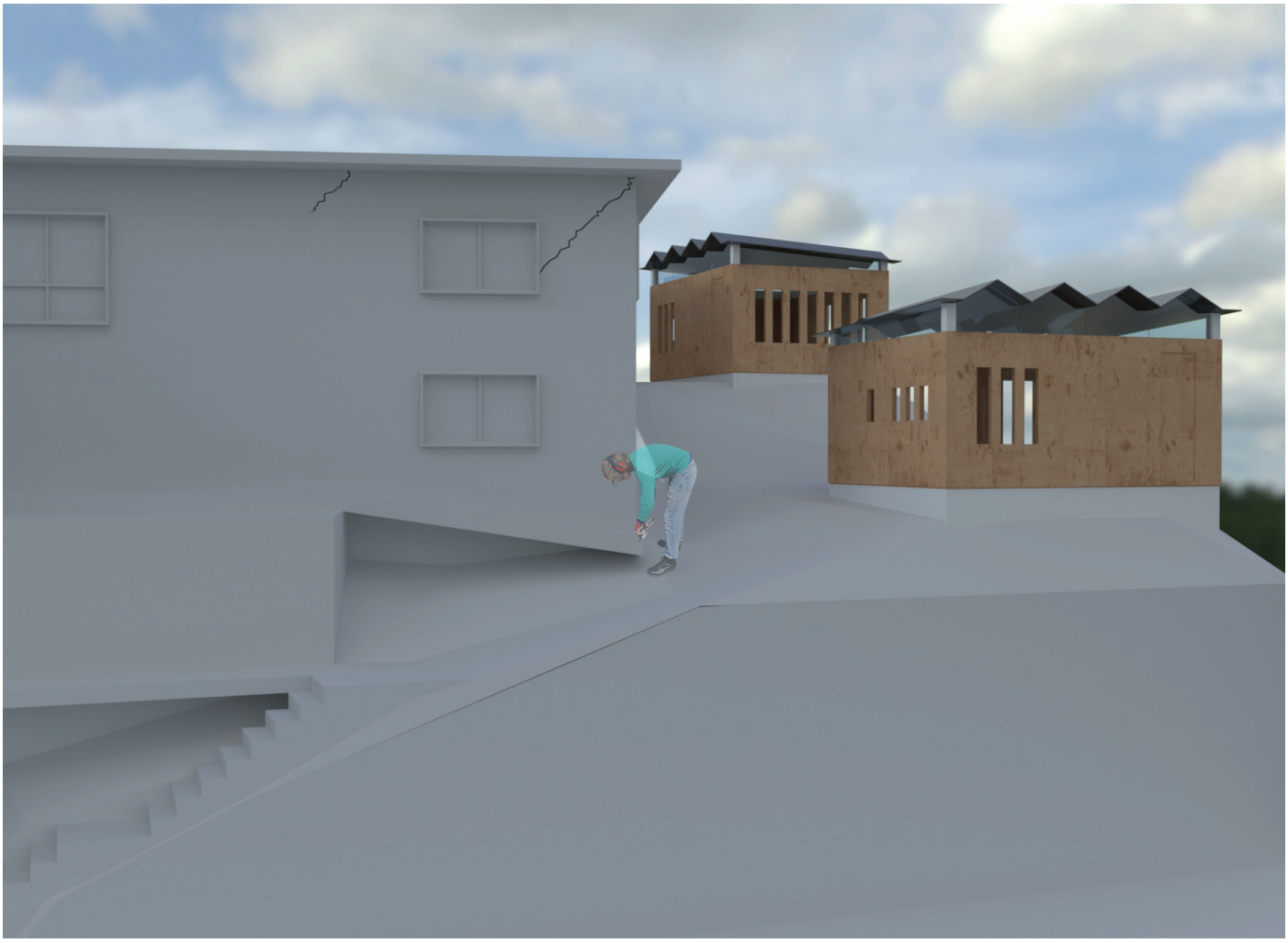


Figure 3.56 1 day post-disaster. The cladding panels are deployed. The transitional shelters are located on the only occupiable land on site.

Figure 3.57 1 month post-disaster. Due to the lack of available land, there is only room for the two initial modules, and two bathroom modules.

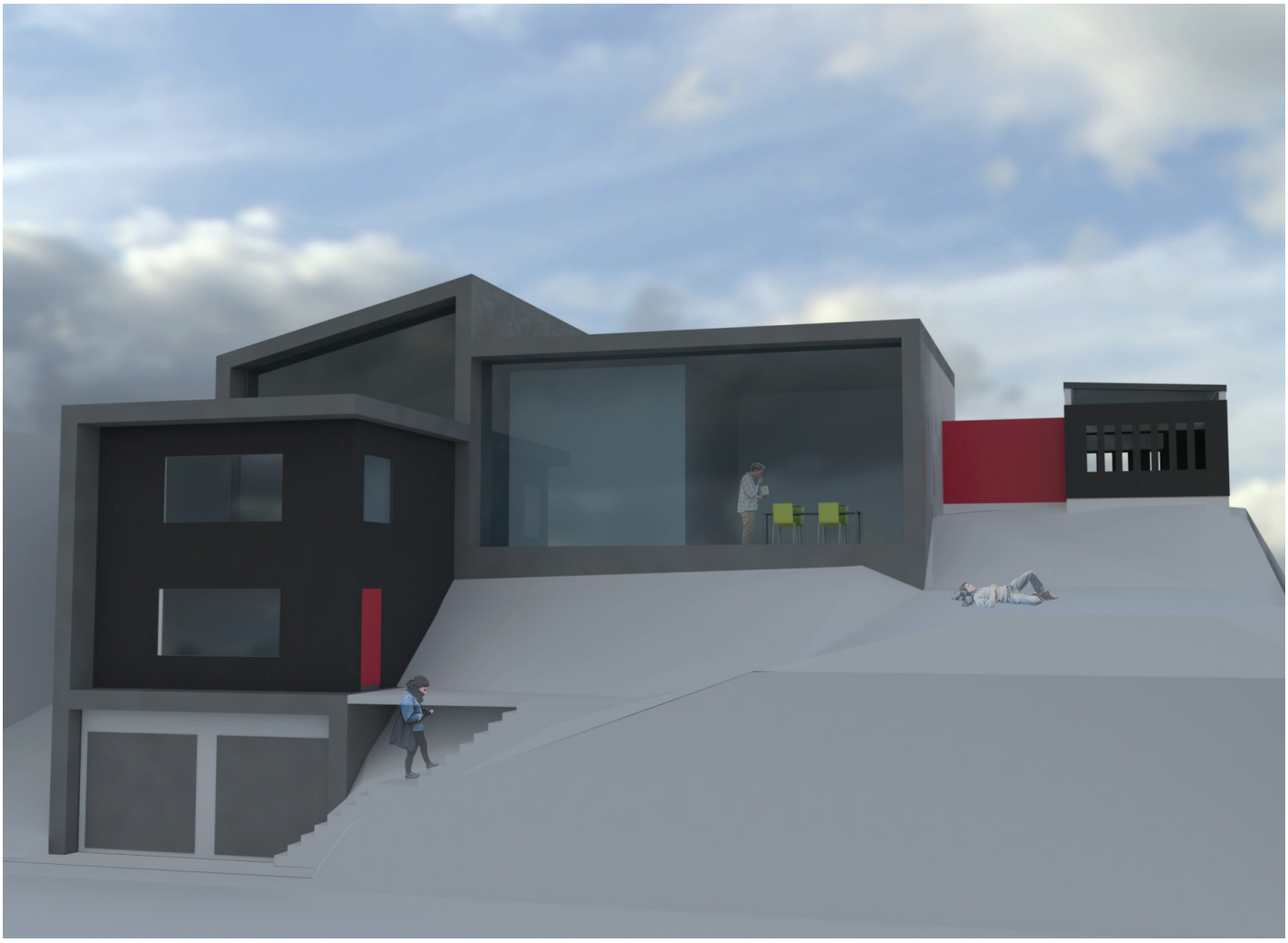


Figure 3.58 12 months post-disaster. The damaged house has been demolished. One initial module remains with adaptations and is attached via a linking module to a new module, which makes up 58 Wallace Street. 58B Wallace Street is a completely new build, and remains respectful of its heritage neighbours through its scale and proportions. The other initial modules are removed from site, to allow for outdoor space. These unnecessary modules will be relocated for reuse elsewhere.

41 Standen Street, Karori, Wellington

41 Standen Street is a 1915 weatherboard villa, with a hip-and-gable roof. Houses along Standen Street are of a similar style, from the same era. The houses are stepped back from the street, and often hide behind fences. There is a great sense of privacy along Standen Street.

Figure 3.59 Standen Street elevation - 1:200

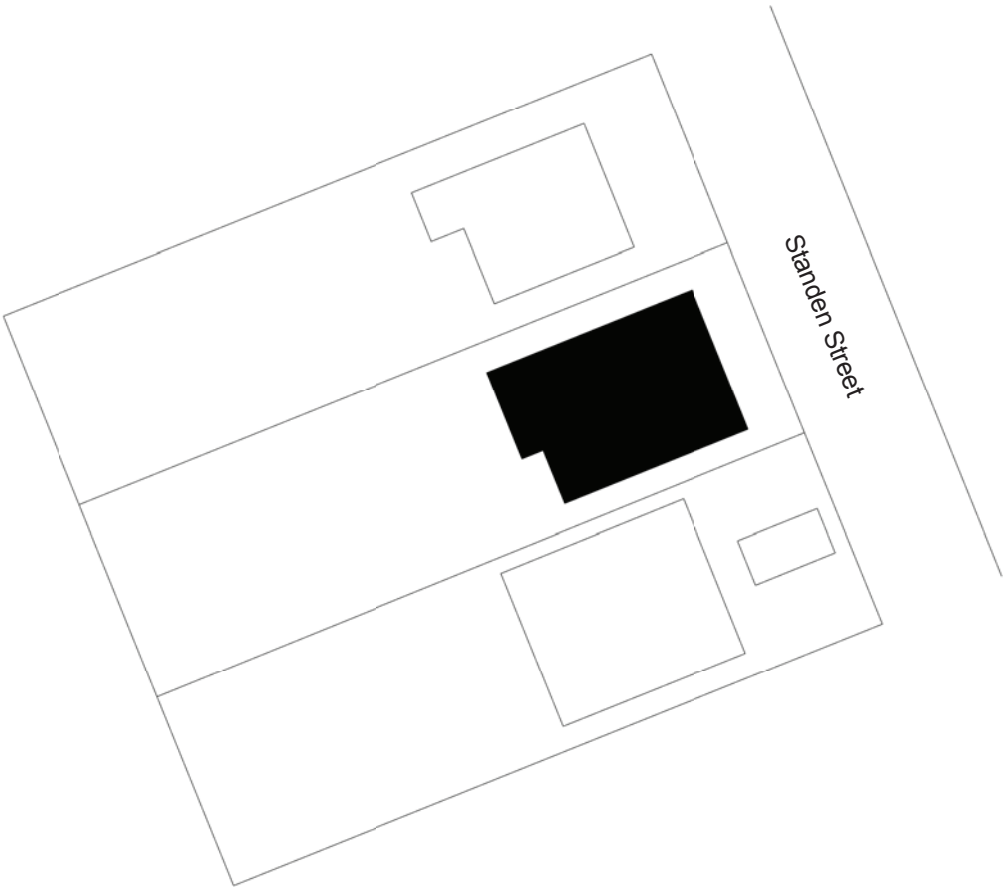


Figure 3.60 Standen Street plan - 1:500

Figure 3.61 Day of a major earthquake. The transitional shelter is deployed without cladding panels, due to the volume of shelters required.

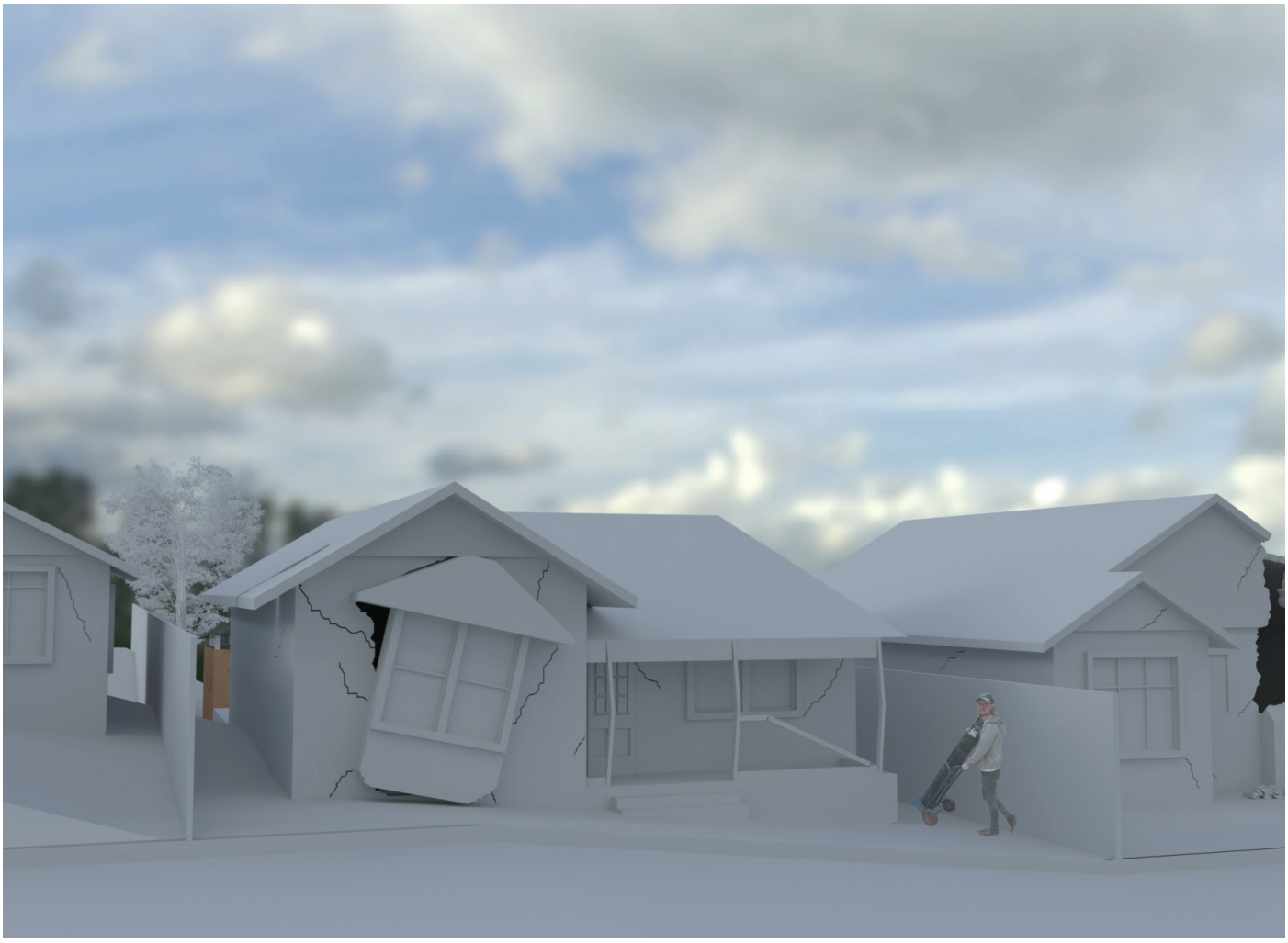


Figure 3.62 1 day post-disaster. The cladding panels arrive. The shelter is located on a flat area of land, situated close behind the existing house. From this point, the transitional house can expand and occupy the front of the site.

Figure 3.63 1.5 months post-disaster. 41 Standen Street has a large site to the rear of the house, which allows for numerous modules to be added to the transitional house. At this stage, only one bathroom module and one additional module have been allocated to every household - however, more can be requested at a later date as required.

Figure 3.64 12 months post-disaster. The damaged house has been demolished. The transitional house has grown towards the front of the site, and the new component of the transitional house is attached via a linking module. The initial modules have been upgraded with new roofs and cladding panels.

Figure 3.65 12 months post-disaster. Due to the style of houses on Standen Street, the aesthetic of the initial shelters would be out of place. Therefore, the new component of the transitional house has been designed to respect the distinctive character of Standen Street. The initial shelters are attached to the new component via a linking module, and are barely visible from the street front. The vertical cladding panels of the initial modules has been continued through the new component, along with an identical paint colour.

Summary

By testing the transitional house on four different sites, it has been established that the transitional house is an appropriate response in a typical New Zealand context. However, difficulties arise on some sites.

Standen Street represents the ideal site, where there is a large amount of space for the transitional shelter to be located. Due to the available land area, multiple additional modules are able to be added prior to the demolition of the existing house.

Awarua Street has enough available land for the initial shelter and a bathroom module, but does not have enough usable space to allow for additional modules to be attached without the existing house being demolished. However, additional modules could be located separately from the main shelter elsewhere on the site, if extra space is necessary.

Wallace Street has two houses on one site, so must have two transitional shelters located on site. The available land has room for two initial shelters and two bathroom modules, but does not have enough space for additional modules without the existing houses being demolished.

Treasure Grove also has two houses on one site, but does not have any usable land available for a transitional shelter. Therefore, a nearby park is used to house the transitional shelters until the existing houses have been demolished. It is assumed that in these instances, the demolition of the existing houses will be at the top of the priority list. After demolition, the transitional shelters can be relocated to site.

The design can be easily adapted to suit individual needs 

SECTION FOUR:

CONCLUSION

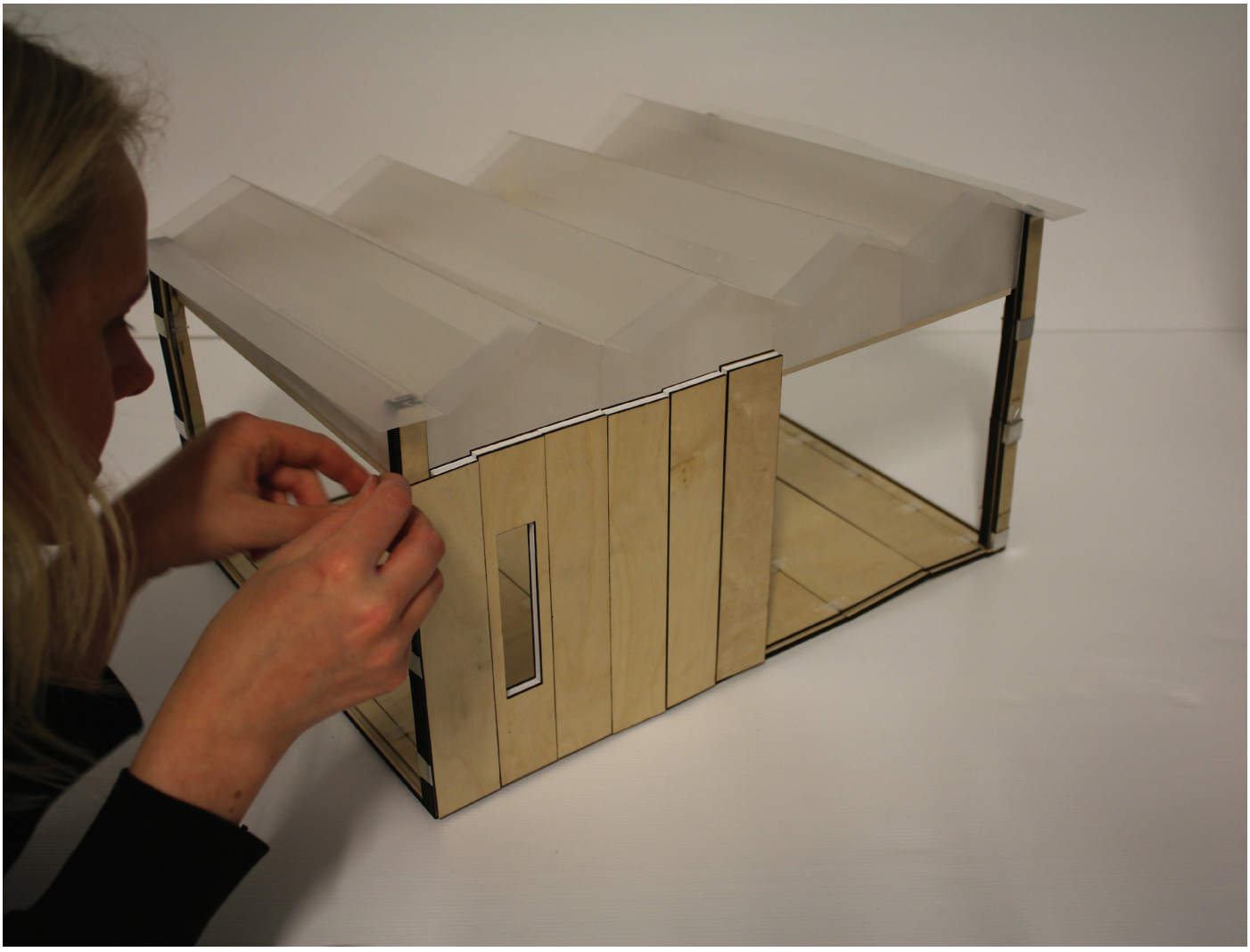


Figure 4.1 Assembling 1:10 scale model

Conclusion

This thesis is an expansion on current architectural discourse about disaster-relief housing. The system failure within architectural humanitarian relief provoked this thesis: how can transitional disaster relief housing become a feasible option in the aftermath of a disaster, rather than the traditional inadequate response? How can such housing become adaptable down to the individual level? These questions are underpinned by the broad issue: how can architecture aid in the immediate reformation of a city?

Through the design methodology of design as research, and an iterative design process, the research has analysed and uncovered ways in which architecture can improve current response issues.

The first section in this thesis revealed the design problems through a literature review, which explored architecture's role in disaster relief and revealed observed tendencies in disaster-relief housing. It argued for a way in which architecture can appropriately meet these issues, and deployed methods in which they can be used.

The second section considered the transitional house as a tool to re-evaluate post-disaster responses. It speculated strategies to transition from a temporary state to permanence, through expansion. It explored the use of hybrid prefabrication, to aid in the efficiency of construction on site. Ideas were tested for their pack-down techniques, for storage and transportation purposes. Simple solutions were found to be effective for cost issues in the fabrication process. It explored how to facilitate siting on multiple land types, so that it can be widely used across New Zealand. Allowance of adaptation, both immediately as a response to context and over time to suit individuals, was explored to different degrees.

The third section developed the design, and set the transitional house as the response to a potential major disaster in Wellington. The speculations in section two were refined and positioned within a critical discussion around architecture's role in aiding post-disaster recovery. It illustrated a significant departure from traditional disaster-relief housing, and proposed the formulation of a

new typology.

This thesis set out to consider the transitional house as a tool to re-evaluate post-disaster responses. Design as research allowed the emergence of a transitional house to develop simultaneously with the critical evaluation of such a response. This enabled a critical design to develop alongside the evaluation of post-disaster requirements.

The implications of this research are for the role of architecture in post-disaster situations. By introducing the need for disaster-relief architecture to change, and by identifying a way in which it might change, this research has implications for contexts both in New Zealand and internationally. Considering how this research might be adapted for international contexts could form additional questions: to what degree could this design work in various international contexts? How could this design be translated into an appropriate response regardless of culture and weather patterns? This research also assumes the demolition of an existing damaged house, and the requirements of a completely new dwelling. Future work could also consider the degree to which houses are damaged, and how they are occupied: could this design be adapted to reflect the possibility of a renovation of a partially damaged dwelling?

Despite whether this research might be adapted to various contexts or not, this approach to disaster relief housing has undeniable importance in the recovery after a disaster: not only in terms of the rebuilding of a city itself, but also the rebuilding of the lives within the city. There is a clear need to extend architectural discourse around disaster-relief housing, and it is hoped that this thesis might serve as a prompt for the exploration of further design research.

List of figures

Figure 3.29 Japan temporary housing - source: Bloomberg. “Japan’s Quake Survivors Still in Temporary Homes 3 Years On”. Updated March 11 2014. http://www.bloomberg.com/news/2014-03-10/japan-s-quake-survivors-still-in-temporary-homes-three-years-on.html 112

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