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I, Sagar S Desai, hereby submit this original work as part of the requirements for the degree of Master of Architecture in Architecture.

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For Whom the Time Stops: picking up the pieces in a world of constant motion

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For Whom the Time Stops: picking up the pieces in world of constant motion

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by

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The frequency of natural disasters globally has risen rapidly in recent decades, particularly the devastating storms and floods that many associate with global warming and climate change, which has shown no signs of slowing down. This leading to many developing countries increasingly vulnerable to natural disasters, and with the lack of resources and rising population growth in these countries, it places many people, specifically ones in informal settlements, to be stranded out on the streets causing land use problems. Understanding that in times of natural disasters, non-profit organizations, such as Red-Cross support the impacted area, this thesis proposes a kit-of-parts to be distributed to displaced families, enabling them to have a starting foundation to self-build a shelter. This kit will contain articulated pieces of structure, design to be assembled or disassembled by the common man, using absolutely no supplementary hardware.

The classic theory of Vernacular Architecture, described by Frank Lloyd Wright as “folk building growing in response to actual needs, fitted into environment by people who knew no better than to fit them with native feeling,” will provide insight into the design language that responds in line with the basic needs of the individuals.

Therefore, the design solution to teach self-build temporary disaster relief shelters with the addition of natural building methods and local resources will allow them to, progressively, convert these structures to a more permanent shelter. As a result, the people of the developing world will no longer be forced to be homeless and start from the beginning, but be able to pick up the pieces of what is left after the storm.
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1 THE ARGUMENT
I. INTRODUCTION : PREFACE

The exploration of this thesis derives from the opportunity of traveling to India in during the monsoon season, summer 2005. The climate encompasses a broad range of weather conditions depending on the geographic landscapes and scales, but considering having family in the south-west region; the focus will be pointed to that particular area. During this four month period, it is expected to be constantly encompassed with severe thunderstorms, making it one of the most dynamic wet seasons on this earth.

During my time there, I was able to experience some of these eye-opening conditions, as the first two weeks of my journey was comprised of constant rainfall and thunderstorms, bringing major floods. This led to areas completely flooded and dilapidated, many being informal settlements in low lying areas and inhabited by the poor and helpless. Families being forced to leave their homes and lives behind, watching everything they had built, invested hours of intense labor, being washed away in the blink of an eye.
That being said, the title of this thesis has multiple meanings. The first, for whom the time stops, refers to the people that are most affected by these disasters, losing everything in the matter of a moment. Following, picking up the pieces in a world of constant motion, is alluding to the reconstruction of their homes and lives, taken away by destruction force of the storm, supported with by little to no help. Moreover, metaphorical expression becoming literal regarding the disaster relief shelter design in itself, where allegory of the “pieces” is corresponding to the kit-of parts.

The core of this thesis will be to propose the re-creation of a shelter to improve the conditions of residents living in informal settlements after a natural disaster. The intent is to study and understand the “housing” situation of these areas – current building method, housing growth, resources available, and above all, the basic needs of the people. This exploration will serve as a comprehension of housing shelter prototypes without drastically altering the existing progression and development.
II. NATURAL DISASTERS

This natural world can be a prominent, vigorous and dangerous place. Life ultimately thrives on this dynamic planet, yet the extremes of nature can undermine the survival of people, even species. As time passes by, more and more people continue to be displaced during and after natural disasters, leading to the rise of devastation, suffering and deaths, caused by earthquakes, droughts, floods, typhoons, avalanches and even, volcanic eruptions.

With no signs of this trend to turn the other way, it would be the opportune time to tackle the causes and consequences for not being ready for displacement. Although policy makers have been pushing towards the progress of humanitarian and sustainable development goals, disaster risk reduction and action on climate change, often not enough attention is given to the displaced.
Conceptualizing Displacement:
in the context of disasters

Displacements could happen from plenty of reasons, for this particular study, the terms and concepts that will inform the investigation and point towards the proposal will be associated with the occurrence of a natural disaster.

Although the widely accepted definitions of these terms are used in commonly used to give a perspective of different types of disasters, natural events, and displacements, some being more fluid and generalized than other, all of which should be interpreted with the context and perspective of which they are developed.

Disaster is defined as the “serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources”.1

Exposure refers to “[t]he presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.”2

Vulnerability refers to “the propensity or predisposition to be adversely affected”. It encompasses a variety of concepts and elements “including sensitivity or susceptibility to harm and lack of capacity to cope and adapt”.3

2 ibid. UNISDR.
3 ibid. UNISDR.
i. The Continuum from Voluntary to Forced Displacement

As in everything, displacement also comes with the continuum of being “forced” or “voluntary” moving locations during time of the disaster. Another way to look at it, displacement measures the reaction to the last minute or the survival response to a hazardous event. The difference between the two types, forced and voluntary, seem quite difficult to distinguish during slower developing disasters. In time of a rapidly evolving catastrophe waiting to happen, people are left to flee their home in the matter of a notice.

With a range of other socio-economic, political and cultural drivers of exposure and vulnerability. These allow people in these situations to take more time and adapt to the impacts done their homes. As for the poor and vulnerable, their survival dependent on them remaining in their “homes”, it would only make sense to evacuate, establishing another form of displacement.

ii. Displacement Risk

As there is a disaster risk, the risk of displacement is also expressed through the threat, exposure and vulnerability:

- The occurrence, strength and nature of disasters happening over time. According to some scientific evidence, climate change is going to be responsible for altering the severity and frequency of weather related disasters.¹

- The exposure of people and their homes prior to disasters and their livelihood, and vulnerability, during and after displacement, as many have to move locations or start from scratch.

¹ IPCC, Fifth Assessment Report, November 2014
ii. Displacement Risk (continued)

These factors not only show the increasing chances of being displaced after a storm, but, also the hurdles displaced people often are confronted with in the duration and efforts of achieving viable solutions.¹

Specific problems they face include landlessness; joblessness; homelessness and worsening housing conditions; economic, social and psychological marginalisation; food insecurity; increased morbidity and mortality through trauma and vulnerability to insanitary conditions and disease; loss of access to common property; and the disruption or destruction of social and economic support networks.²

 iii. Internal and Cross-Border Assistance

Majority of the people who evacuate to another location, typically stay within the country, and described as internally displaced people. As stated by the Center of Internal Displacement, in most areas, many families hit by this tragedy are really just seeking protection and assistance.³ As some countries are not as fortunate as others, in times of disaster, global and across-the-border non-profit organizations will bring support to the impacted countries.

A durable solution for displacement would be to find an option to give families assistance in building a foundation for their new place of residence. Disaster hits people in numerous ways, some families forced to start from scratch, sometimes left with scraps from their previous settlement, but not enough to reside.

² ibid, Cernea.
³ Nansen Initiative, Cross-border displacement in the context of disasters and climate change: A protection agenda, Draft for consultation, 08 April 2011
The Global Picture:

scale, patterns, and trends

Studies, done by the Internal Displacement Monitoring Center, show that since 2008, the average amount of individuals displaced from their homes each year due to natural disasters is roughly 26.4 million people. More recent estimates, in 2014, state more than 19.3 million people were displaced in over 100 countries.\(^1\) The number of people being displaced every year vary greatly, all depending from the type and size of disaster. Even though the number seems like its dropped, the change in fluctuation in numbers is directly being driven by the weather related events that displace millions of people at the same time.

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i. Displacement by Type of Hazard

Even the smallest and gradual increases in climate can affect the rate and intensity of the disaster and the vulnerability it brings to the people. In 2014, the largest increases in displacements were related back to weather and climate hazards, and floods, which left 17.5 million people displaced. The three largest to hit that year were caused by both typhoons and floods in India and the Philippines.

With the higher temperatures known to increase the chances and severity of droughts and heavy rain, and rising sea levels to add onto it, more exposure and vulnerability are towards people living along the coastal flood plains. The intensity and frequency is projected to have a continuous rise in the coming decades.¹

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ii. Trends in Exposure and Vulnerability

Displacement patterns being based by countries’ exposure and vulnerability to natural disasters. The two constantly shifting as far as hazard patterns, seeing no significant changes in a short period.

The combination of global warming, climate change, and the rising population living in areas prone to hazards, informal settlements, there comes an increase of people exposed to vulnerable situations. With the consideration that natural disasters are unpredictable in the occurrence of the place, ranging from mild to extremely destructive. The displacements being closely reflected to the urban population and economic growth.

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¹ IPCC Special report on managing the risks of extreme events and disasters to advance climate change adaptation (SREX), 18 November 2011.
iii. Urban City Centers : Developing Countries

The urban population in developing countries, growing twice as fast compared to the rest of the globe, at a rate of 326 percent increase since 1970. When urban growth is planned and managed accordingly, the risk and rate at which displacements occur may increase modestly. The issue in many developing countries, unfortunately, the growth has happened rapidly, unplanned and poorly managed, leading to many people moving to low lying, coastal flood zones, allowing them to have higher exposure and vulnerability to displacements.

With the influx of people moving into the urban city center, the growth of informal settlements will respond at the same rate, being a big concern for developing countries, especially in times of natural disasters. As many of these countries are already in financial trouble, limited in resources available, and a lack of governmental assistance. And while some families may be in a better financial situation and be able to manage through the displacement, most are still residing in the informal settlements, also known as squatters or slums, have very few resources to prepare for and recover from.

For example, in countries such as the Philippines, India, Nigeria, and others, there are large populations of people who live in coastal and river floodplains. Settlements in these areas were formed for the proximity to urban life and lack of habitable and affordable land.
People in this situation are more likely to be exposed and vulnerable to natural disasters, and due to the lack of practical alternatives, often return to the same area after being displaced, only with nothing or just the pieces left behind.¹

Defining Squatters:

Squatter settlements, also known as slums or informal settlements, are typically found on the outskirts of the city line. These settlements formed on public or private “vacant land”, housing the poor, with shelters built of scraps, plastics, metals, anything sturdy. Since the construction of their “shelter” is fairly informal, there is no city grid, or any organized urban planning. These areas are also known to lack basic public amenities or services, everything from no sewage, electricity, running water, and garbage removal to disease control services.¹

For the millions of poor in developing countries, residing in urban areas come with the connotation of improving quality of living and environment, may it not be to get better jobs and incomes, but to get out of the declining conditions and situations in the rural areas. With the necessities of needing some kind of housing, and very few resources, skills or access to them, occupying “vacant” land to build a shelter is only one of few, but most important problem to resolve.

¹ Jorge Hernández. “Sólo tres unidades de bomberos atienden 2 mil barrios de Petare”
i. The Squatter

Therefore, a “squatter” is considered to be the person who settles on public or unauthorized land or building. Squatters and slum dwellers, most of them from the rural countryside, reveal the lack of opportunities, therefore move to the city and claim open territory.

Among the number of assumptions and generalizations of squatters and slum dwellers, some of the more important:

   I. Squatters and slum dwellers have the resources, skills, and motivations to provide adequate shelter for themselves

   II. When given security of tenure and other assurances and resources, squatters and slum dwellers build their own homes and improve them as their life situations improves.

   III. Squatters and slum dwellers develop their own market mechanisms to avail themselves of materials needed for shelter

   IV. Squatters and slum dwellers have valid reasons for choosing locations of their communities and are, therefore, their own best planners

With some of these characteristics stated above, squatters and slum dwellers are often considered as “a solution and not a problem”, the people living in these conditions are faced with new challenges every single day, yet figure it with little to no resources available to them.

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ii. Resources, Skills, & Motivations

Studies done by Laquian, state that slum communities have been known to have active organizational capacity, good construction and production skills, and strong community and personal motivations. When they have no other option, but to provide for their families, they will figure it out and continue to work hard. According to case studies on, invasion, and other similar slum settlements, also shows, low income communities hold strong leadership, management, and production structures, which would allow them to take on intricate tasks and responsibilities. Being recently moved from the rural areas, most people still come from the traditions of self-built homes, having come with skills and traits for construction and maintenance.

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III. VERNACULAR ARCHITECTURE

Architecture addressing basic needs, from local and natural resources, and reflecting local building traditions. Vernacular architecture originated when mankind was forced to provide his family with shelter, with nothing besides natural resources, but being responsive to the outside forces, such as climate. This concept has allowed many generations and civilizations, even before the architect, to construct a shelter based off of their circumstance.¹

Over time, vernacular architecture will develop in accordance with its context: the environmental, cultural, and economic influences. Contrasted with polite architecture, which is heavily based on stylistic elements, making the purpose fulfill aesthetic needs, going beyond functional needs.²


² Holm, Ivar. 2006 [Ideas and Beliefs in Architecture and Industrial design: How attitudes, orientations, and underlying assumptions shape the built environment]. Oslo School of Architecture and Design. ISBN 82-547-0174-1.
Vernacular and the Architect:

i. Paul Oliver

As stated before, vernacular architecture practice of creating a shelter for basic human need, with only local and natural resources, therefore, architecture designed by a professional, does not constitute it being vernacular. As Paul Oliver states in his book, Dwellings,

“...it is contended that ‘popular architecture’ designed by professional architects or commercial builders for popular use, does not come within the compass of the vernacular”

“...the architecture of the people, and by the people, but not for the people.”

The success of this book does not come through the compilation of fascinating reference work on domestic buildings, but the research in the traces of theoretical development culture, gender, sociology, anthropology and its link with understanding how dissimilar communities respond to various challenges they are faced with every day.1 The question being, how do these traits bring cultural and symbolic meaning to the evolution of architecture?


1 Ibid. Oliver.
ii. Bernard Rudofsky

A writer and an architect, a key figure in organizing a series of exhibitions at the Museum of Modern Art, New York in the 1940s, 1950s, and 1960s. In one of his exhibits, also a book, Architecture without Architects, was held at the MOMA, in which he displayed black and white photography of vernacular structures around the world. Due to the success and response he got from the exhibit, it is Rudofsky, who is known to use “vernacular” in context of architecture, insisted and brought attention to the practice and concepts of vernacular architecture:

“For want of a generic label we shall call it vernacular, anonymous, spontaneous, indigenous, rural, as the case may be.”\(^1\)

Through the books he has written, he establishes a sustainable argument for humane and sensible design. He believes people should be open to more than just a “few cultures,” by that, he attempts to break the limited idea people often have with the field of architecture and introduce readers to ‘nonpedigreed architecture’ (vernacular). The lessons learned will only be useful to mankind, especially with the natural environment crisis and occurrence of disasters the world now faces.\(^1\)


Influences on the Vernacular:

From gathering information from the previous sections, it could be seen, vernacular architecture can be influenced by a wide range of different aspects, responding to human behavior and environment to the construction of the shelter through resources available to them. Even with many wide variances in the result, every building follows the generic laws of building, hence the similarities in structural form.
i. Climate

One of the most key influences on vernacular architecture is the climate of the area each of the shelters constructed. For example, in cold climates, they are built with great thermal mass or lots of insulation to prevent heat loss, and vice versa in warmer climates, by contrast, built with lighter construction materials and allow for portals in the design for cross ventilation.

Building also take different forms depending in amount of rainfall in the region, flat vs pitched roof, also with the possibilities of raising the entire shelter of stilts. And similarly, in areas with high winds, leads to in certain ways that would be able to cope with them.

Even though the straight forward, simple response, climatic influences on vernacular architecture need strategic planning and can sometimes be very complex. Every little force can truly play a huge role in the way each element is constructed on the shelter, may the final design be similar in form.
i. Culture

The life of this building, how is it being used, the occupants, all influence the form and design of the shelter. This is where the user of the shelter plays an important role in the design and layout of the dwelling, as the size of the family, who shares the space, interaction between people, any cultural considerations all matter.

Two types of dwellings:

Nomadic Dwellings

Many cultures around the world possess some type of the nomadic life, as they have developed vernacular solutions for the need of a shelter. All have responses for the outside factors, such as climate or family customs. The Nomadic people use materials common to the area to build temporary shelters, as will change with their financial stability. They use anything sturdy enough to use as a panel for their “shelter”, but light enough to transport. When choosing materials, another thing to consider is transport, sturdy enough to work as shelter, but light and simple enough to move locations if needed.

Permanent Dwellings

As nomadic people use lightweight and simple materials, these people not so much. Depending on how permanent people choose to be, the material pallet and type of structure speak accordingly. As time goes by and financial situations rise, the materials used for the shelter, also become heavier and more stable.

Although starts at the same spot as nomadic people, these people decide to build a more permanent dwelling through the use of more solid and durable materials.
2 SITE ASSESSMENT
Mumbai, India, the capital city of Maharashtra, being one of the most populated urban cities in the world, home to 21 million people.\textsuperscript{1} Located on the west coast of India, its neighbors are the Arabian Sea and the inner coast of India. With a profound natural harbor along the Arabian Sea, an alpha world city, Mumbai is the wealthiest city in the India.\textsuperscript{2} Due to the current density of the city, estimated to be about 20,000 persons per kilometer, and continuous population growth, now more than half of Mumbai’s population lives in shanties around the city. Most slum dwellers live off of one US Dollar a day, work long hours in the sun, the rivers used for cleaning, bathing, and even toilets, and living in make-shift shelters. In addition, an estimated 200-300 families moving into the city every day, Mumbai is set to be the slum capital of the world.\textsuperscript{3}

\begin{itemize}
\item \textsuperscript{1}“India stats: Million plus cities in India as per Census 2011.” Press Information Bureau, Mumbai (Press release). Press Information Bureau, Government of India. 31 October 2011.
\end{itemize}
II. REGIONAL ANALYSIS

Dharavi, located in Mumbai, houses one of the largest slum populations in the world. First founded in 1882 in the rise of the factories, people from the rural poor decided to migrate to the city center, in pursuit of a better lifestyle. Since then, the slum has grown to about one million people with an area coverage of 217 hectares (535 acres), accommodating a diverse group of people and settlements.1 Located right under the Mithi River, which empties out into the Arabian Sea. Due to its location in a low-lying area and poor drainage systems, it makes the slum particularly vulnerable to floods and displacements during the monsoon season.

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Society

The people from this squatter community are considered to be a low-income population, lacking means of basic needs and resources to enhance their livelihoods. They live on low lying land along the Mithi River exposing them to flood vulnerability and risk during the monsoon season.

Migrated from all parts of India, Dharavi has a diverse group of religions residing there, two of the larger being Muslims (30 percent) and Hindus (60 percent). Among the people who live there, about twenty percent work in animal skin production, tanneries and leather goods, while the others specialize in manufacturing goods in textiles and pottery, retail and trade, distilleries and other similar things, all of which could range to the scale of a single home.¹

The housing situation follows path of the high poverty levels, as the informal settlements are compiled through bring scraps of metal, plastics, anything sturdy to become a building materi- al. Most of the settlements are self-built shelters, varying in accordance to the resources available to them, as well as their financial situation.

Dharavi faces many other challenges, along with the most obvious of shelter. People living there have limited access to electricity, clean water, food and educational opportunities. Education and literacy are not on the list of priorities, as families need their children to help provide for basic survival.

Environment

Even with the influx of people that live in the small, Dharavi is mainly made of low-rise buildings with narrow street structures that make it very cramped, close to impossible to navigate through. The slum is so densely populated that it feels like it’s a city of its own, filled with slim dirty alleyways, open sewers, and more trash than one could imagine.¹

i. Work Environment

The work environment being extremely hazardous and unsafe, leading to many injuries, diseases and deaths. For example, even for people working with coal burning situations with smoke everywhere, temperatures at 150 degrees F in the room, and people still will not be wearing proper body gear or face masks.

One of the more unique to see is the work-place environment Dharavi has to offer. There is no wasted land, as every piece is used for production of some sort. Considering the fact that everything is done by hand is the enticing, since society today is reliant on the hi-tech industry.\(^1\)

\(^1\) Ibid. Binsky.
ii. Residential Environment

As the work environment may have some sort of infrastructure for the larger industries on site, the residential areas, lack any sort of infrastructure, such as roads, toilets, and public services. Broken sewer lines, piles of trash, stray dogs and cows pooping in the street and doorsteps, and people drinking, bathing, and doing laundry in the same contaminated stream. The residential areas are merely divided by religion, as temples, churches and mosques are spread throughout the site, each serving members of their respected areas. Each home is merely a tiny room with open floor space, serving up to eight people, no kitchens, living rooms, or bathrooms either. Laying bodies covering the entire width of the shelter, no pillows, mattresses or even blankets. Ninety percent of all housing units in Dharavi are informal, making hundreds of thousands of makeshift shelters all across the site. All of which, so fragile that they could collapse at any given moment, especially in times of disasters.
Economy

Even with the lack of access to many resources and equipment, Dharavi is considered one of the most productive slums, as it’s over a billion dollar industry. It produces goods and merchandise that is exported all around the country and the world, markets in leather products, jewelry, various accessories and textiles.¹ The most common businesses include works in pottery, leather, plastics and steel, but a large recycling industry employs almost a quarter million people to process recycle waste from all parts of Mumbai, which is why it is considered to be the recycling “hub” of the city.²

The area has an estimated 5,000 businesses, plus another 15,000 single room factories. Even with the large amounts of exports produced each day, the average wage still ranges from 50-100 rupees per day ($1-2 US).³

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² Waste not, want not in the £700m slum, The Guardian, 4 March 2007
³ Ibid. The Guardian.
3  PROTOTYPE
I. CONCEPTUAL DESIGN
PRINCIPLES

The criteria for the disaster relief shelter are set with the understanding of how things are done in the Dharavi, as well as understanding the people who reside there. It can also serve as a foundation for post disaster relief shelters for slum and shanty towns.

The design of the shelter will be based off of three primary concepts:

- Modularity
- Versatility
- Sustainability
Design Principles:

i. Modularity

This shelter will not be a finished object, but rather a kit-of-parts for the structure which will allow people to build one on their own, just like how they build on the site now. This kit of parts will also come with a how-to-guide on how to assemble the frame together. Ikea furniture, a perfect example of how the kit of parts would be done, just like one would get a package from Ikea with instructions on how to put the item together, the only thing, this time it would just be of the main structural elements. The rest would be dependent on the individual to finish, as they are familiar with building with local and natural resources.

The assembly of this shelter needs to be straightforward and easy enough for people to put together, but also to take apart as these modules of structure could added and taken away upon the need of the user. In allowing the main structure
and educating the people how to build with local and natural resources, it gives them a bit of flexibility in the orientation and positioning of the doors, windows, and even the size of the shelter itself, within the boundaries.

The advantage of using a modular system, such as this, allows for better user intervention and for future growth or adaption of these structures. This could also been seen in the eyes of a recovering process for the people that get displaced in times of natural disasters. As the people have to take a leadership role in the rebuilding of their community.
ii. Versatility

Most shelters, especially disaster relief or temporary, are typically just used for one functional use and that is to be a shelter. The concept of the shelter to have one or more uses for it is very important due to the fact that these “temporary shelters” for people living in informal settlements in developing countries, really becomes their “permanent” structure, until it also is taken down.

With an open structural frame, but the use of using local and natural materials to fill in the gaps, will allow flexibility in how each of the “panels” will be used. For example, the same type of building methods, using the same materials, will allow for a floor panel and wall panel to be exactly similar but also different with the addition of windows, doors, storages, etc. The versatility will also aid in the expansion or contraction of the structure upon need basis.
iii. Sustainability

This concept is closely in relation and tied to the previous one, as have versatile functions, for the entire shelter or its components, becomes more sustainable in the sense of the life span of the shelter. If things over time need to change, or expand/contract, it could easily be done by switching out the panels.

Since the first main structural is manufactured and engineered, it is important to know that, the components are only a one time use, it would be high inefficient and uneconomical to transport. The crate the kit of part will come in, will also be able to be used on the panels of the shelter, as extra structure for the materials to latch on to, or to help with the function of the additions: doors, windows, storages.
UNIT
based on a single unit
II. THE EXPERIMENT INVESTIGATIONS

The final design of the prototype-shelter was generated through the further development of the concepts discussed in the previous section. The design will be a combination of a kit-of-parts given to the families displaced from the natural disaster with the application of self-building with local and natural resources.

The design developed through the investigations of three distinct but interdependent areas:

- Culture
- Joinery
- Material

These kits are suggested to be given by the non-profit organizations around the world that support regions hit by natural disasters, such as the International Committee of the Red Cross, which support families and regions in conflict or...
providing relief in natural disasters. The idea is that families are given the support to try and shape their community back to what it was prior to the storm, in the same fashion growth happens there now. They are given the main foundation and structure of the shelter, with a guidebook in teaching how to make the joints and assembly on how it’s put together, in help of future development plans.

As stated in Disaster Assistance Manual: Transition Housing for Victims of Disasters,

“In design work decisions, all are drawn on at one and the same time. A cultural attitude can influence building orientation or the choice of walling material. A structural choice for a core house may determine whether or not a family can safely extend using traditional materials they have readily on hand.”


Investigations:

i. Culture

The cultural aspect is the key distinction between other disaster relief shelter and the one proposed. The design of the disaster relief shelter addresses the vernacular architecture found in the area right now. As seen by the pictures of the slum, most of them being rectilinear and small in size, the idea is to keep the traditional language. Because of the modular system of the structural frame, the shelter will be able to grow vertically as a unit, and create pathways and networks when placed next to another shelter. This will work along the current one-two story structure that exist now, with small alleyways that create secondary networks within the informal settlements.

Due to the modularity of this shelter, it allows certain panels to be interchangeable and reconfigure spaces for different purposes. For example, many shelter in Dharavi currently are all in one
spaces, or live-work spaces, all depending on the need of the client. The modularity also helps with the further development of these shelters, going from a one to two story structure, from using temporary materials to permanent over time and the family’s financial situation.

Because of the religion and culture play such a strong role in the layout of the spaces, only providing a structural frame and letting the families take care of finishing up the rest with the use of vernacular materials, will also allow them to have some flexibility in the final outcome of their shelter.

In terms of the covering the open areas, because the structural members of the shelter are most important, at the beginning, a piece of cloth or tarp would be sufficient to enclose the space. As electricity and running water are not a factor in most of the cases, that is not the subject of this topic. The idea is to help provide a shelter for the families displaced and affected by a disaster.
ii. Joinery

As mentioned in the conceptual phase, this project is based on the ease and simplicity of assembling and disassembling the structural frame. The intention was to figure out construction details in which the shelter can be put together without the use of any additional hardware, have flexibility in growth, and most importantly, allow for additions of windows, doors, shelving and storage.

The joint was inspired by Amish Barn Raising,

“...construction should take about two days to complete and does not use any nails, only wooden dowel pins to connect the structure’s beams and joists.”

With an open structural frame, but the use of using local and natural materials to fill in the gaps, will allow flexibility in how each of the “panels” will be used. For example, the same type of building methods, using the same materials, will allow for a floor panel and wall panel to be exactly similar but also different with the addition of win-

dows, doors, storages, etc. The versatility will also aid in the expansion or contraction of the structure upon need basis.

Full barns are put together in the matter of a few days max, all due to the joinery detailing, and no hardware. Simple beam and joist system, with dowels acting as nails and screws. The shelter was designed in the same style of joinery, as people can follow a how-to-guide provided with the kit of parts to assemble the structure. This joint was also considered due to backgrounds of many people who moved into these informal settlements, knowing carpentry, masonry, etc. work from the rural areas. If families did want to add to the existing structure, those joints could be imitated without too much of a difficulty.

As for some of the other type of joints, for shelving, openings, and storage, the simple, notch and groove was used. The secondary member could attach by sliding it into place. Ensuring the joint is locked and the freedom of movement is limited in the direction it could move.

Overall, the joinery system was set up in a very particular order, so that the main structural frame would be set up before the secondary elements came into play. The assembly of these details are clear enough that they could be conveyed through the images alone, which is very important in informal settlements, as literacy and education rates are at a low.
ART OF JOINERY DESIGN
...as much as science

The Design of Timber Joinery is as much Art as Science. This Technical Bulletin will Cover the Fundamentals of Engineering Timber Joinery without the Aid of Hardware.

RULE #01
The geometry of the joint should have mating surfaces that allow structural loads to be transferred in bearing of one member against the other.

RULE #02
The wood removed to create the joint should not unduly weaken either member.

RULE #03
The geometry of the joint should not be altered by shrinkage of the wood and bearing surfaces should remain in tight contact.

RULE #04
Anticipate all potential modes of failure and provide sufficient strength to resist each potential failure mode.
iii. Material

The selection of materials chosen for this relief shelter were based on the structural joinery aspects and also the availability of local and natural resources to build. For the main structural frame and secondary elements, wood was the obvious choice since the joinery played a significant role in its choosing, as well as, the overall strength and sustainability in terms of a building material.

As far as, filling in the voids, the wall panels, floors, roof, it is proposed that people will start by using temporary materials and transition to more permanent as the financial situation changes. From studying the area, climate and industry, it was found that Dharavi is considered the recycling hub of the city and known to be in a subtropical climate. Both of which helped in choosing the materials for an option that was tested and used as building material in other developing countries. Since, Dharavi is the hub for recycled material, choosing plastic bottles would not be a bad idea to use as a structural element in for the panels. And with the weather, it would reasonable to building with natural materials, such as soil, manure, and clay. Many others in developing countries make adobe bricks the same way, these panels could be made in modules, like the shelter itself, and embedded within the frame to enclose one of the panels.
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