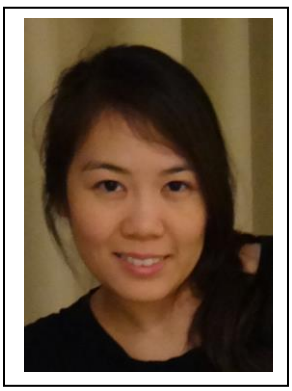
Combatting Concrete & Climatic Considerations for Social Housing in Metro Manila

Striving for thermal comfort in medium rise buildings through improved climate smart housing design



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1 Introduction

The primary methods of construction in Metro Manila for social housing include the use of hollow concrete blocks (HCB) and cast in place or prefabricated concrete slabs. These building methods result in many homes that are built with little consideration of insulating from the intense heat of the local climate, and beyond this, the housing designs lack provisions for natural ventilation which is necessary to reduce the amount of heat felt at the human comfort level. Poor housing designs have forced residents to consider air conditioning units, however, many families who are in need of social housing do not have the finances to afford this luxury. Above this, many homes are not designed to be air tight and even with an air conditioning unit, much energy is wasted and the full capacity of the cooling unit cannot be taken advantage of.

In the dense area of Metro Manila the National Housing Authority (NHA), in partnership with many Non-Governmental Organizations (NGOs) such as contractors or developers, provides the majority of social housing for citizens who are in need of this support. There may be opportunity for self-build housing and systems that use the notion of ‘sweat equity’, but there are also many more denser developments that will be built by private contractors or developers through a design-build competition process. This paper will focus on methods and materials that will improve housing design, with specific consideration for local climate, that the NHA can suggest as design requirements to be employed in future medium rise social housing developments.

2 Post-War Use of Concrete in Social Housing

There are an increasingly large number of families flocking to Metro Manila from the rural provinces in hopes of finding livelihood. Many parents want to provide better opportunities for their children including having access to better education. This has led to rapid urbanization and has presented the city with dire housing challenges as the number of families who settle in informal areas steadily grow. The current density in Metro Manila is already 18 087 persons per km^2 yet there is an estimated need for over 1 700 000 housing units in the National Capital Region (NCR) according to the NHA. It is a challenge they are currently addressing, in order to “improve the lives of people, value, pursue and advocate freedom from homelessness” (Valenciano 2014). One way to solve the issue is to look back into history to see what has been previously done in other parts of the world. Then one must be critical and decide whether or not the solutions were effective, and whether or not they will be suitable for Metro Manila.

Rapid urbanization and lack of housing is a trend that has been seen before in post Second World War Europe. Many approaches were taken by different nations to solve this issue, but generally across Europe nations decided that they should “include state housing provision as a key component with the Welfare State” (Jenkins et al 2007:153) and so many housing developments surfaced across Europe. In the beginning, many of the housing typologies were single, low-rise units situated at the edges of main urban centres, built by both conventional and self-build building methods. A few issues arose with this housing movement. First, many were dislocated from their original source of livelihood and little support was provided to help families find new sources of income. Second, the low density developments caused a movement of unsustainable urban sprawl and poor land use. Additionally, the "conventional and self-build forms of housing were expensive for the vast majority of the population and did not meet lower income groups' needs, but in fact tended to benefit growing middle classes" (Jenkins et al 2007:157). Furthermore, the building methods of the time, conventional or otherwise, could not keep up with the growing demand for affordable housing and it was realized that housing developments needed to be densified to meet those demands. Building denser housing typologies were especially relevant for developments being erected in more central locations in order to provide households with better livelihood opportunities. Medium rise and high rise buildings were thus introduced into the social housing sectors of many European nations.

Photo 1: Rise of concrete towers, http://www.efla2011.com/program/technical-tours.html

Reinforced concrete became the most common medium to use in social housing developments after it proved itself to be a "formidable weapon in the arsenal of the Cold War" (Forty 2012:149). As a building medium and method, concrete was well suited for medium and high rise buildings, as it was quick to erect and did not require skilled labourers. Although these factors helped to boost the post-War economy and provided affordable housing for the urban poor, there was a want to build faster and cleaner, particularly in the former USSR where the demand for housing was so great since the destruction from the war had prevented new construction for six years. The answer for the former USSR was to turn to prefabricated concrete panels and to standardize housing designs (Forty 2012:150). This allowed them to speedily deliver thousands of homes in a very short time to meet quantitative demands, however, the quality of the housing provided is another matter of discussion. Precast concrete was undoubtedly a product of the Zeitgeist and became increasingly popular as the need for unskilled labour and efficient construction methods grew in importance, not only in the former USSR, but also throughout the rest of Europe in the post-War era.

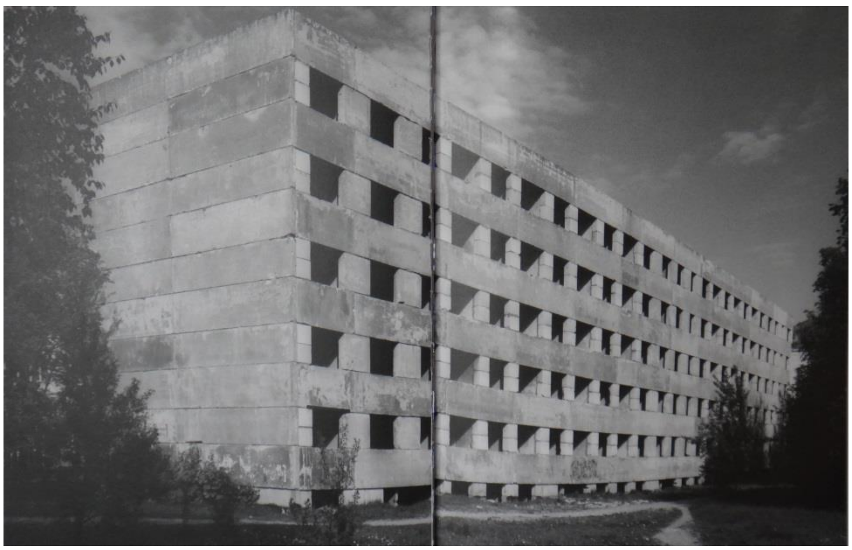


Photo 2: Abandoned concrete building in Lasnamae, Tallinn, Estonia (Forty 2000:154)

Towards the end of the 20th century and after the collapse of the Soviet Union, across Europe, the previously marvelled at, monotonous concrete structures became unfavoured, monolithic, deteriorating symbols of the Cold War. Buildings slowly became unpopulated and deserted, and deterioration from lack of maintenance became the norm. Many cities were left with “an unfinished aesthetic of medium to high rise buildings that [were] poorly insulated and decaying. These deteriorating buildings became progressively abandoned cities of concrete” (Forty 2012:167), many of which have since been demolished.

The progression of the use of concrete in post-War Europe is similar to the current situation in Metro Manila. Concrete is the medium of choice to deal with the challenges of rapid urbanization and the “continued fast growth of urban populations and the inadequate supply of conventional housing in relation to need and real demand [is] quickly [leading] to growing ‘slums’ and squatter settlements" (Jenkins et al 2007:156). The NHA is working closely with local government units (LGUs) and NGOs to combat this situation with both relocation and upgrading projects throughout the NCR and beyond. A majority of the housing projects that have been built recently have used a combination of reinforced concrete framing with CHB wall infill, or cast insitu and precast shell concrete construction. Like in the former USSR, concrete likely became the primary choice because it is economical in that contractors can hire low-skilled labourers, and it is speedy due to the nature of the medium. Although both materials and methods are widely used around the globe, there are, however, concerns and inefficiencies with these two methods of construction.


Photos 3 & 4: Reinforced concrete with CHB construction & cast insitu shell concrete construction

The first concern with concrete is its impact on the environment. It is a major contributor of CO_2 emissions and often ends up in landfill sites if not properly recycled. Although measures are taken now to increase the recycled content of concrete, it is not an inherently sustainable material and its use should be limited and/or used in conjunction with other construction materials. The second concern, specifically with CHB, is that it is not earthquake resistant, which is especially of importance in the Philippines, being situated in the disaster prone Ring of Fire. Conversely, the shell concrete construction method that has been adopted from France, used by developers like Phinma Properties, is believed to be earthquake resistant. Although designing for disaster resiliency is important in the Philippines, the focus of this paper is on the quality of spaces, specifically human occupancy comfort levels with respect to climate considerations of social housing developments.

The key concern to be discussed is not simply the choice of concrete as the construction medium, but the way it is being used. From personal field study observations in the Philippines, concrete structures are being built without holistic consideration for a building system that is suitable for the hot humid climate of the Philippines. Throughout the year, Metro Manila receives between 10 and 20 hours of sunlight daily and experiences mean temperatures ranging from 23˚C in the winters to 33˚C in the summers. Above this, the city will experience 60% to 95% relative humidity in the winters and summers respectively. The human thermal comfort level is generally acknowledged to be anywhere between 20˚C and 24˚C. Housing designs need to be able to sustainably combat these warm temperatures and provide a comfortable space for human occupancy. Two issues regarding the current housing designs will be discussed further: poor building envelope performance and spatial design for ventilation. In both methods of CHB and shell concrete construction, insulation is not being used in the building envelope. The usual exterior finish is a layer of plaster and paint.

Photo 5: Plaster and painted concrete shell structure at Bistekville 2

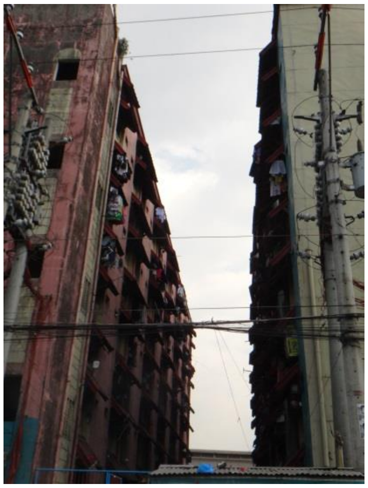
Concrete is inherently a thermal mass which will store heat from the many hours of exposure to the sun during the day and will release it at night. Without shielding the concrete from the sun, interior environments will be extremely hot during the days and even through the nights. Some building and unit layouts allow for cross ventilation while other designs do not allow the units to breathe. Suggestions will be made in the following section on how to improve the current housing design situation with respect to climate considerations and thermal human comfort.

3 Housing Design with Climate Considerations

In Addition to Concrete

Although CHB is known to have better insulating qualities than concrete slabs, an 8 inch CHB made with light weight aggregate, without insulation has a U-value of 0.36 W/m^{2}K. Compare this to an 8 inch concrete slab which can range in U-value from 1.67 W/m^{2}K to 0.83 W/m^{2}K depending on the density, which is less than half of the thermal resistance of CHB. Additionally, a study done by Shu et al. shows that adding insulation into the core of CHBs can further help reduce heat transfer by half, giving the system an average U-value of 0.18 W/m^{2}K (Shu et al 1979:431).

Beyond adding insulation to the core of CHBs, in both concrete methods of construction, insulation should be added to the exterior wall to protect the structure from UV rays and sunlight, minimizing heat transfer to the interior as well as minimizing long term damage to the structure.



Photos 6 & 7: Deteriorating concrete at Sofia Bellevue & Smokey Mountain

Alternative materials currently in use in the Philippines that should be explored in medium rise developments are woodwool slabs and other cement fibre boards. They both offer good thermal insulating qualities and can be produced sustainably with local materials. The thermal conductivity of woodwool vs. lightweight concrete of the same density are 0.085 W/mK and 0.10 W/mK respectively (Johansson 1994:6), meaning concrete allows much more heat to pass. These products should not only be considered for wall construction, but also in roof and floor applications. Research done at the Technical Institute of Khartoum by Mukhtar shows the ability of insulation to greatly reduce temperatures at the roof level when the temperatures outdoors are high. See figure below.

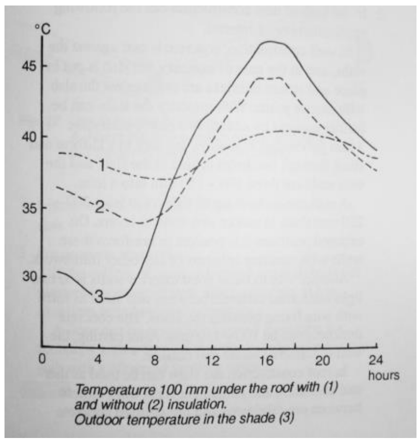


Figure 1: Temperatures under roof level with and without insulation (Hermansson 1993:13)

Cement fibre boards and woodwool panels could also be used as permanent formwork or shuttering in the building process thereby adding insulation to the envelope system and increasing thermal comfort within.

Prefabricated Structurally Insulated Panels

Other options to explore are prefabricated structurally insulated panels which are widely available in the market today. One product already presented to the NHA is the Steel Reinforced Concrete Panel (SRC). The composite includes a polystyrene insulation core providing thermal and acoustic insulation. It has a total wall system U-value of 0.568 W/m^2K and twice the structural capacity of CHB. For the same reasons the former USSR adopted a prefabricated panel system, this panel system can drastically reduce construction time, giving better economy to this choice of construction. Regardless of which panel system is selected, consideration should be given to local materials and available resources.

Considering Climate

Spatial layout and design is crucial in promoting natural ventilation through a housing unit. A concrete box will become unbearable in a hot humid climate if air is not allowed to pass through.

Photos 8 & 9: Housing units in Bistekville 2 - exposed concrete finish, lack of natural ventilation

Openings and louvers should be provided on multiple walls of the unit to allow for cross ventilation. Also orient buildings strategically to maximize natural air flow and minimize sun penetration. Avoid back to back, boxed in units that would hinder natural ventilation.

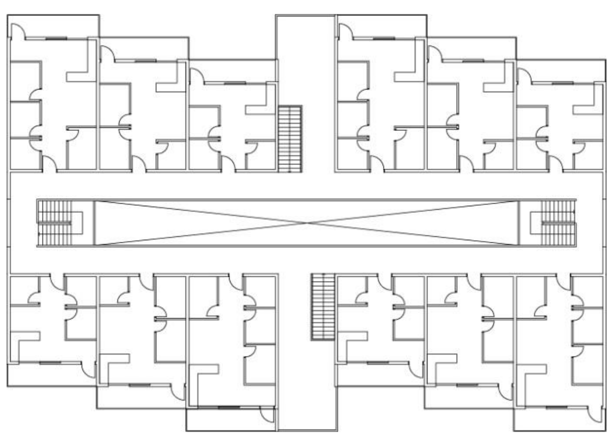


Figure 2: Plan showing possibility for cross ventilation

Another approach to promoting ventilation is to use more permeable construction materials. In order to achieve disaster resiliency as well, Correa has suggested that a portion of the unit should be constructed of solid concrete materials, serving as the core area in case of emergency. Additional spaces can thus be built using alternative materials such as perforated fibre boards or bamboo (Correa 2000:68).

Beyond the Envelope

Adding greenery to the outside of a building can help reduce temperatures of interior spaces. In addition to the aesthetic benefits of a green environment, studies have shown that the installation of a living wall system can greatly alter the temperature of an envelope. In said study, the exterior wall's surface can be reduced by 20.8˚C while the interior surface can be reduced by up to 11.58˚C (Chen et al 2013:3). The benefits of green roofs and green walls are great in helping to reduce the heat island effect of urban areas. A simple green wall or roof system can be selected to keep costs low, but regardless of the system, careful attention must be paid to the detailing in order to prevent water damage to the structure. Beyond the skin of the building, providing additional shading with broad canopied trees is also recommended.

4 The Role of Architects

When multiple organizations work together to realize a social housing development, there needs to be transparent discourse between all the actors. There will be many stakeholders and decision makers in the process who will need to be educated about smart design choices that are sustainable, disaster resilient and climate considerate. This is the role of the architect. Each architect from their respective organization, whether it is the NHA, an NGO or the LGU, should work together and design holistically to achieve the best housing and master plan design possible for each specific site. In doing so, the entire context of people and places must be explored, analysed and understood by whatever means necessary in order to provide the people with a safe and salubrious community.

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All images are property of the author unless otherwise noted.

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