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# THERMAL COMFORT IN MASS AFFORDABLE HOUSING FOR HOT AND HUMID REGIONS: DESIGN STRATEGIES FOR LIG & EWS AT THIRUNINRAVUR, CHENNAI

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***ABSTRACT***

*Housing demand continues to be on a high in spite of the recent increase in construction prices and lending interest rates. Recent survey by ANAROCK states that nearly 63% of the available housing inventory across the country falls in the affordable and mid segment category. The industry in order to deliver more housing units within shorter span of time is adopting monolithic concrete technology for walls using aluminium formwork in both private and public sector housing projects in the metros in India. At this juncture it is also noticed by the report published by Centre for Science and Environment [17] that the energy demands from such residential units would sky rocket due to heat becoming trapped within them. In the quest for mass housing coupled faster construction and delivery of housing units, thermal comfort* [1] *and on ground affordability have to be factored. Accomplishment of the goals only on arithmetic terms of national housing policy merely by faster construction time to increase supply of housing units with poor thermal performance may not be a worthwhile endeavor. In this paper, an attempt has been made to use architectural design strategies to explore possibilities for better thermal comfort for mass housing for the affordable housing sector as a part of M. Arch Housing Executive thesis (2022).*

***Keywords:*** *Thermal comfort, affordable housing, warm-humid, concrete technology*

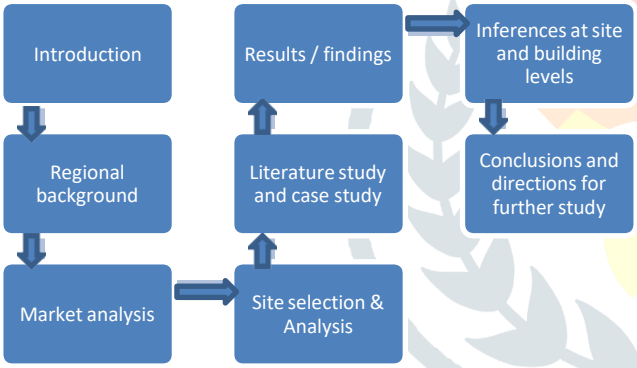


***Fig1:*** *Graphical Abstract*

## 1. INTRODUCTION

An advertisement in the daily newspaper from an established private real estate developer reads as "A Next Gen investment with a Next Gen offer". Another advert reads as assured rentals, easy on your pocket, get your second home says the next, most suited for senior living says another. All these ads may be made to sound differently but they have a common agenda they have target to sell the 1BHK flats. There is no doubt, and nothing totally in correct about it. However, it could also be seen as an obstruction to realizing the national policy to achieve housing for all by 2022. This over the top marketing strategy also hides behind the fact that the dream of many to own their first home at an affordable cost may remain a distant dream. This is true as most of the housing units sold under the label of EWS Economically Weaker Section [13] aren't intended to be soldto people from Economically Weaker Sections.

The label of EWS developed by private developers is conveniently translated as 1BHKs, studio apartments and compact 2BHKs just because the floor area is around 60 Sq.m., but it is sold on par with the prices that match the other apartments designed for the middle and higher income groups within the housing complex. The idea behind reservation of 10% to EWS housing [13] in the development control rules for large residential developments seems to have yielded muted results with the intended beneficiary at bay. The governmental agencies are doing their task better in social equity as they have a transparent procedure for allotment and identification of beneficiaries while this is notto be seen in private developers in the city. [15]. World BankReport

**Aim and Objectives**

The aim of the proposal is to bring about livability and improve quality of life in the housing units planned and designed for the marginalized viz. EWS and LIG (Low Income Group). The 2014 report on housing shortage by KPMG – Project Management Consultant [14] reveals that 95% of the national housing shortage is in these segments.

The objectives of the proposal are as follows:

1. To identify large cheaper land parcels in a thriving sub- urban region with primary residential and mixed use development to achieve affordability and livability.
2. To restrict vehicular access and parking zones and prioritise safety of pedestrians and improve walkability and encourage cycling between the blocks on campus.
3. To provide open areas, tree covered landscapes, ample play spaces for children and avenues of interaction.
4. To design modular standardized building blocks and components for use of prefabrication technologies.
5. To achieve thermal comfort is the primary motive and to achieve this, the following parameters are necessary [1]; functional efficiency [2], economy and aesthetics [9].

The scope for this proposal springs out of the PMAY (Pradhan Mantri Awaz Yojna) guidelines that provide definition for EWS and LIG housing in the country. PMAY defines EWS as the one with an Annual Household Income up to Rs.3,00,000 and house sizes or maximum carpet area of upto 30 sq.m. LIG is defined as the one with an Annual Household Income from Rs.3,00,001 to Rs.6,00,000 and

house sizes or maximum carpet area of upto 60 sq.m. The next aspect was about the construction technology. Taking a cue from the Global Housing Technology Challenge (GHTC)
[10] that recommends alternative technologies based on '3S' mantra of Skill, Scale and Speed. With this background an earnest attempt was desired to take shape through the thesis work is arriving at a balanced proposition for housing the economically weaker.

## 2. REGIONAL BACKGROUND

The housing real estate sector in the city of Chennai caters to a wide segment of home buyers. In spite of the pandemic the southern and western micro-markets continued to dominate the real estate activities in the city. These regions together accounted for 93% of the supply and absorption. While central and north Chennai saw very minimal projects. While south Chennai records almost all housing projects for high and middle income groups. Low income groups find no options in south including portions of west Chennai till Arumbakkam, Koyambedu and Annanagar. L and prices have spiraled and have become unviable for EWS or LIG proposals to come up in these zones. Even Tamil Nadu Housing Board majorly develops HIG and MIG housing in these regions. The land cost varies between Rs.25K to Rs.32K per sq.ft in residential upscale in south and central Chennai; Rs. 18K to 20K; Rs. 9K to 15K in suburbs of south and west Chennai; 5Kto 10K in north Chennai.

Hence, the price of apartment / flats are in the price range between 16K to 23K per sq.ft in prime locations and 4.5K to 10K in most other locations; while there is no apartment being sold at 3K per Sq.ft in the entire greater Chennai extent. It needs to be noted that the selling price per sq.ft of flats developed by TNHB does not vary much between MIG (Middle Income Group), LIG or EWS. Like all developers the land cost dictates the prices even for affordable segments promoted by the governmental agencies. The first time home buyers from low income groups need to choose between rental housing in ill-maintained housing societies within the city or purchase apartments in far flung regions and travel for 30 to 50Km for work, school or higher education each day.

The city of Chennai has a warm to hot humid climate. The dwelling units need to be well lit and ventilated as thermally comfort is very essential. In the last decade the use of clay bricks for construction of residential units have drastically reduced due to their cost and have been replaced by concrete blocks or monolithic concrete walls due to their advantages of cost and time. This has increased the energy consumption amongst dwelling units since the building envelopes of these units have been found to have poor thermal performance [17].

In April 2022, the Tamil Nadu State government issued a set of guidelines for constructing houses which are energy efficient and absorbs less heat in the summer to these two nodal agencies and make it affordable and comfortable without need for Air conditioners. It is a positive sign that the TNUHDB (Tamil Nadu Urban Habitat Development Board), TNHB (Tamil Nadu Housing Board) have now adopted ECBC (Energy Conservation Building Code) norms in their own projects. Few private developers like Mahindra Lifespaces, BBCL are already leading the way by securing platinum green certifications for affordable housing projects too. Green design needs to become accessible for the economically weaker sections at large.

## 3. METHODOLOGY

The proposal has been derived across three levels. The three levels are 1. Site selection and analysis 2. Literature study and case study & 3. Design of the modular unit and the residential campus. Research papers recently published on the subject of prefabrication [3] in mass housing were studied and analysed. The inferences drawn at the end of the said studies, relevant guidelines were utilized in developing the proposal. Certain criteria were selected to form the set of key deliverables in the design development phase.

The vision of PMAY (U) to provide dignified, affordable housing close the workplace for the target beneficiaries became the key guiding factor along with identification of cheaper lands parcels that had a vibrant neighbourhood.

### 3.1 Site Selection

The site was chosen upon a market study and analysis of guideline values chosen site is located in Thiruninravur, along SH51 (State Highway 51) facing the Thiruninravur lake in a primary residential neighbourhood 29 Km west of Chennai Central. Area of the site is 65,100 Sq.m. The site has been analysed on following five criteria, (1) Location (2) Guideline value (3) Existing amenities (4) connectivity (5) Access and axis. Based on the above study conclusions were made in zeroing down on this site from amongst other sites.

### 3.2 Site Analysis

The site analysis was done on eight key parameters: (1) Traffic Analysis (2) Orientation and climate (3) Thermal Comfort (4) visibility (5) Parking zones (6) Pedestrian friendliness (7) Space and form (8) Landscape and Play areas. Based on these, conclusions were drawn and design was developed.

### 3.3 Literature Study and Case Study

#### 3.3.1 Literature Study

The literature study analysis was done on five key parameters: (1) Thermal Comfort (2) Climate and Orientation (3) Prefabricated technologies (4) Mass Housing (5) Cost (6). Based on these, conclusions were drawn and taken up to develop the design.

#### 3.3.2 Case Study

The case studies were carried out at both site and building level as discussed earlier. The projects were selected on the basis of their site areas, construction technologies, and cost of the project. The selected case studies were:

1. Lakeside Apartments by VME Precast in Kundrathur,Chennai (Primary Case Study)
2. Purwankara Windermere at Pallikaranai (Primary Case Study)
3. The Golconde Ashram, Pondicherry (Primary Case Study)
4. Nagakin Capsule, Tokyo Japan (Secondary Case Study)

These four projects were analysed based on the five parameters for site and eight parameters for building.

## 4. RESULTS / FINDINGS

### 4.1 Conclusions from Site Selection:

1. Located 10Km from Avadi town, the site selected is very close to Pattabiram where TIDEL Park Phase II being developed by the TN Govt. It is close to several industries in the belt and hence will appeal to the target group for EWS / LIG.
2. The guideline value and market value of the land is R.600 to Rs.800 per Sq.ft. which helps in making the project affordable and livable without making it extremely dense.
3. Schools, nursing homes, hospitals, cinema theatres, places of worship for different religious groups, post office, ration shop, retail outlets, ATMs and several other amenities are all existing within 800m to 1.2Km distance from the site.
4. Already well connected by road to all parts of city, the suburban railway station Thiruninravur is just 1km from the site and the closest proposed Metro Rail station is at Poonamallee Bypass is just 20min away.
5. With two roads abutting the site, one the 30m wide State highway SH51 and the other the 9m wide road at the rear which enables easy access both for vehicular and pedestrians.

### 4.2 Conclusions from Site Analysis:

1. Multiple entries and exits will be advantageous for large sites. OSR (Open Space Reservation) or open spaces along the entrances may act as a buffer for oncoming and outgoing vehicles to enter or exit safely.
2. The geometry of the site is utilized to the best advantage providing North-South orientation to achieve minimal sun exposure and ample cross ventilation for all the blocks.
3. The distribution of large open spaces interspersed within and in between building blocks aid in allowing air movement to improve thermal Comfort.
4. The visibility and imageabiltiy factors should be in harmony with the local context and evoke a sense of pride for the residents.
5. Parking zones should not interfere with pedestrian movement between blocks.
6. Presence of shaded pedestrian walkways and vehicle free spaces between blocks to be planned.
7. Form follows function is an adage to be adopted to achieve planning efficiency and economy in design.
8. Providing play grounds, parks & tree lined avenues to make the campus friendly in all weather.

### 4.3 Conclusions from Literature and Case Studies:

*: Site Level:*

1. Onsite parking based on design requirements and development rules should be complied to prevent parking on public roads.
2. Thoughtful landscape design with native species will be easier to maintain for residents.
3. Pedestrian friendly spaces between blocks and application of eyes on the street concept to make the campus safer for children and elders.
4. Open areas, play spaces with scope for resident interaction activities.

*Building Level:*

1. North-South Orientation and singly loaded corridors of building blocks provide ultimate thermal comfort.
2. Hollow core precast [16] concrete slabs provide better insulation and reduce direct heat gained by radiation through the roof.
3. Precast modular concrete wall panels helps make big savings in time and cost.
4. Design of operable shading devices can regulate air movement, provide shade and privacy and thermal comfort

## 5. DISCUSSION

The design proposal was developed by following the results and guidelines obtained from studies mentioned above.

*a) Plan form design:*

1. The main entrance and exit to the site is from the west through the 30m wide SH51A Periyapalayam Highroad and also from the 9m road to access it on the east. This later becomes the two way peripheral road and the primary vehicular route within campus. OSR is located in the North-west corner and makes the entry safe as it comes around bend as a buffer. Site Plan in Figure 3.
2. Conceptually the site planning has been done to zone out corresponding parking requirement as surface parking closer to the building blocks.
3. The shape of a baseball playfield that compliments the built form forms the central lung space of the site which is an open playground with shaded walkways all round.
4. The formation of the streets is made angular and discontinuous to discourage erring motorists.

*b) Built form design:*

1. The 13° to 15° angle between index, middle and ring fingers form the configuration of 3 linear modular branches of a single unified residential block. Each block is desired to be prefabricated [4] and hence modular.
2. This form enables the formation of the vertical core at its node. Two elevators, a staircase, electrical, fire fighting shafts occupy the corner which acts as a buffer from east west radiation.
3. Apart from the service stair as a common one in the node each singular block has a staircase in the middle thereby no unit is more than 20m from the closest stairway.
4. Each modular block comprises of a stilt floor with a staircase in the middle block with dwelling units in the ground level on the rest of the two angular blocks. The idea of a partial stilt typology is to act as a multi-use space and to act as a shaded link between blocks. A Few retail shops can also find scope in the stilt to meet the needs of residents.
5. A total of 10 EWS blocks and 6 LIG blocks are proposed. The floor plans of EWS and LIG have two variations. Each block is G +9 with maximum height of 29.75m to optimize on setback of 7m between blocks as per TNCBDR 2019 rules.
6. The singly loaded corridors provide well lit aisle ways that double up as streets into which the house extends sometimes as is the case in most EWS and LIG housing. Horizontally operable lovers make the inner façade of the blocks along the entire corridortoo.
7. The front doors to the dwelling contain horizontal operable louvers in the upper portion to help in air movement without compromising privacy / safety. Similarly all windows are modular with horizontallyoperable louvers too making the façade elegant and modern.
8. Incidentally, the overall symmetrical design gives rise to a clean geometry of repeated, rotated forms that ring with the local mythological symbol of the thiruninravur – the thirumann.
9. The entire terrace is proposed to be used for installation of solar panels to generate energy of approximately 17.6KW through 144 cell panel.

## 6. CONCLUSIONAND DIRECTIONS FOR FUTURE RESEARCH

The chosen site is primary residential as per proposed land use zoning master plan. The idea of the possibility to achieve density, affordability and thermal comfort [7] is attempted by the proposal. Strategies such as singly loaded corridor, part-stilt/part ground + 9 typology 100% north-south orientation, reduction of number of lifts by providing a common core, application of modularized floor plans for EWS and LIG to facilitate economy of off-site construction have been explored. It is now available for the other researchers, building professionals, governmental and private developers to develop this further so that it benefits the first time home buyers from lower income and economically weaker sections of our society.

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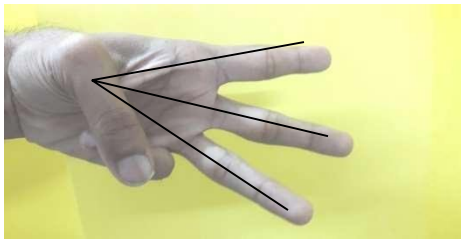

**Figure 1** THE 13° to 15° ANGLE BETWEEN INDEX, MIDDLE ANDRING FINGERS FORM THE CONCEPT (Source: Author 2022)

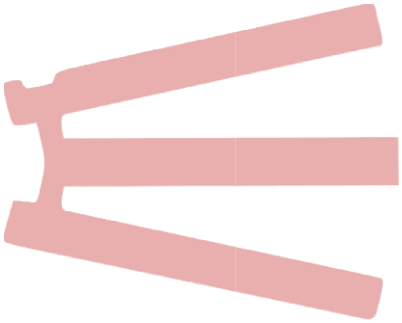

**Figure 2** THE BASE MODULAR PLAN (Source:Author 2022)

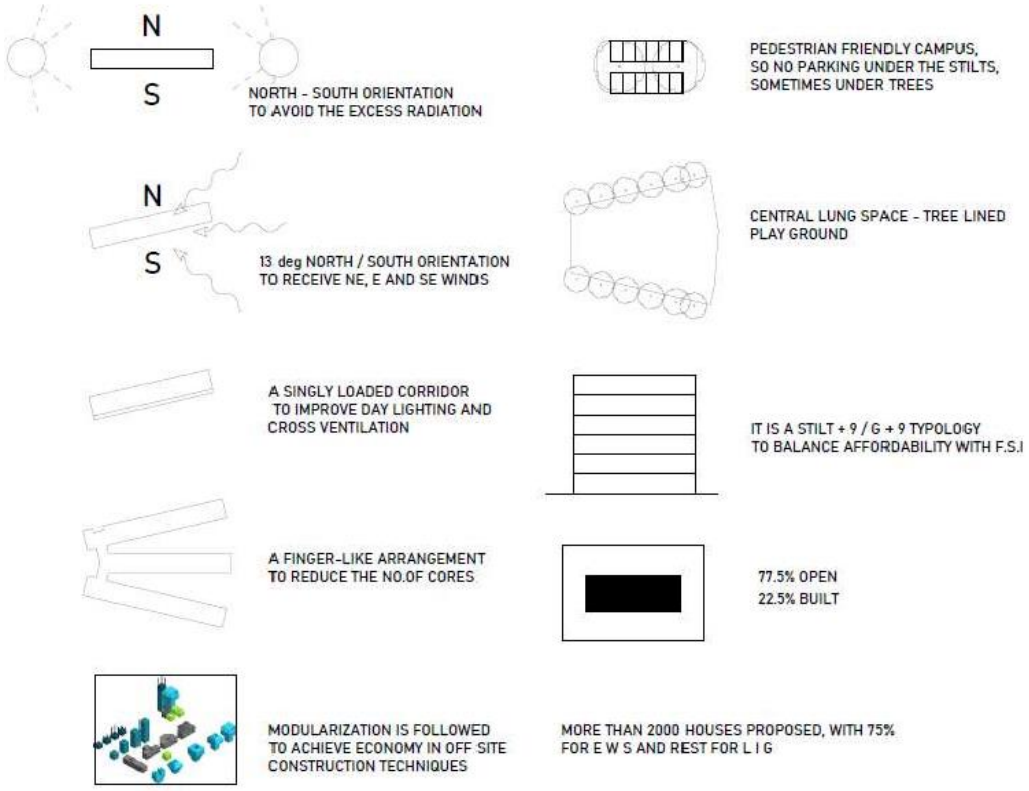


Figure 3 THE CONCEPTS AND STRATEGIES (Source: Author 2022)

Figure 4 THE SITE MODEL AND SITE PLAN (Source: Author 2022)


Figure 5 THE SITE PLAN (Source: Author 2022)

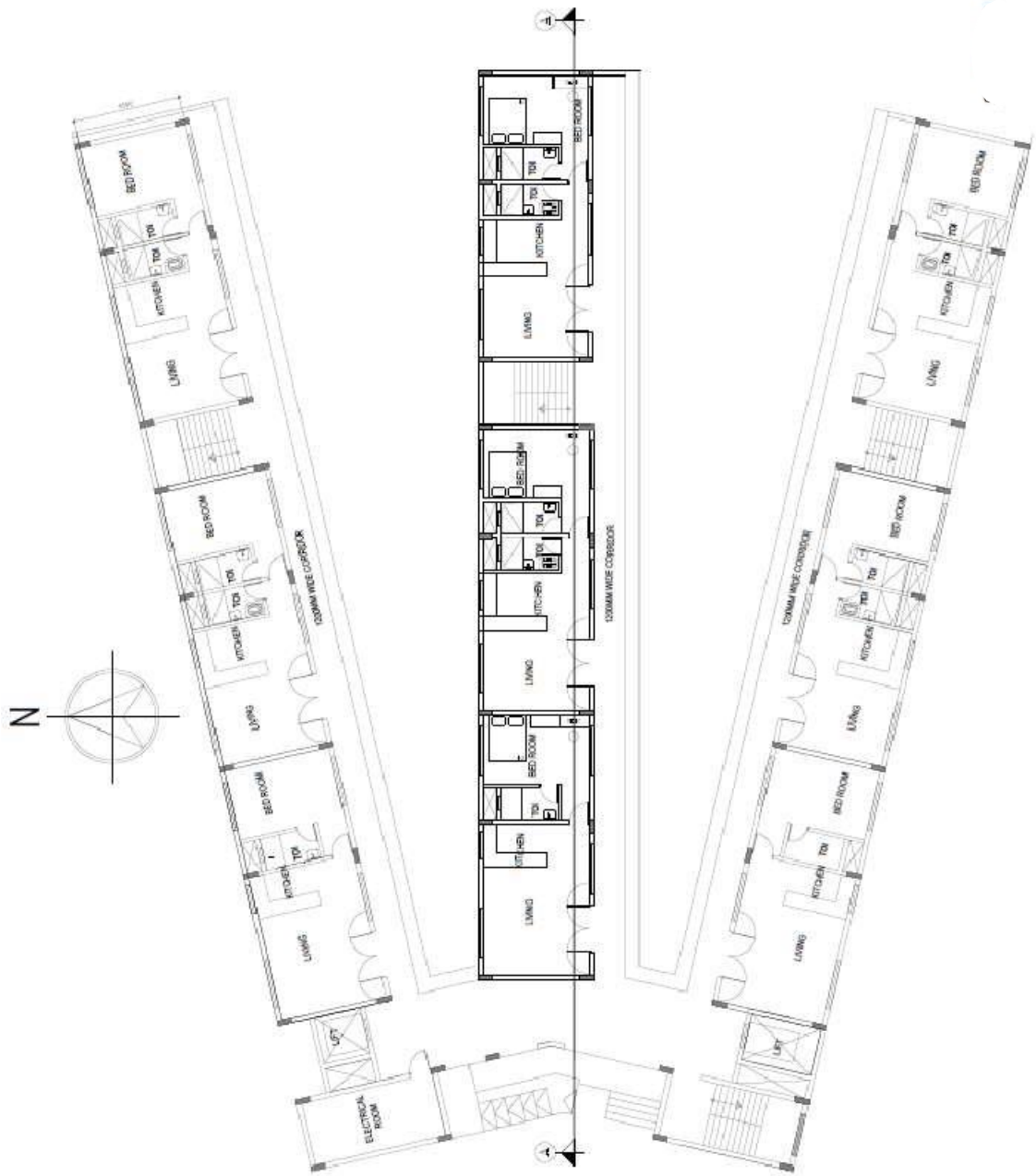


Figure 6 THE TYPICAL FLOOR PLAN OF LIG BLOCK -1$^{ST}$ TO 9TH (Source: Author 2022)

Figure 7 THE INNER ELEVATION OF THE EWS BLOCK (Source: Author 2022)

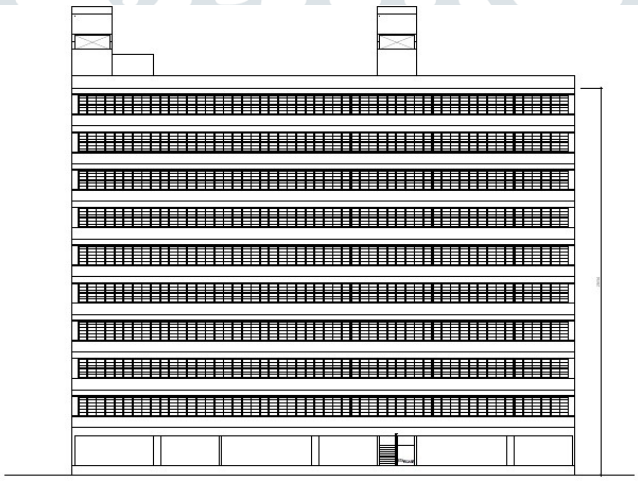

Figure 8 THE INNER ELEVATION OF THE EWS BLOCK (Source: Author 2022)