EXPLORING THE THERMAL PERFORMANCE AND MECHANICAL PROPERTIES OF COGON GRASS (IMPERATA CYLINDRICA) AS AN ADMIXTURE TO CONCRETE ROOF TILE

INTRODUCTION

Extreme changes in temperature and rising heat index have been prevalent across the globe, wherein coastal areas suffer evidently. Most low-cost buildings in coastal areas in the Philippines tend to use galvanized iron (GI) sheet roofing without insulation, as well as ceiling, which contributes to an increased discomfort due to heat. GI sheets also deteriorate and rust faster in coastal areas. Thus, it is imperative to create a roofing material that has insulating properties made with locally available materials relevant to the context of coastal areas.

The goal of this research is to increase thermal comfort in buildings by utilizing affordable and easy to acquire raw materials to produce a roofing that is sustainable. Cogon grass was applied for its affordability and thermal insulating properties, whereas concrete was utilized for its strength, longevity, and non-combustible characteristics.

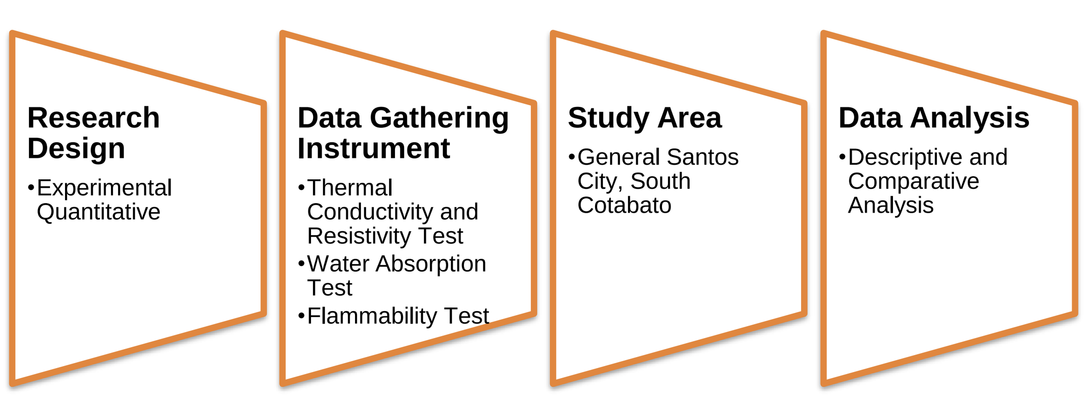
Thus, this study focuses on exploring the thermal performance and mechanical properties of cogon grass as an admixture to concrete to create a roof with insulating properties – developing an effective building material for low-cost buildings in the coastal areas and contributing to various ways to mitigate heat perceived by the users.

RESEARCH OBJECTIVES

This research aimed to develop a roofing material with thermal insulating properties, without additional synthetic inputs. It also aimed to make use of the locally available renewable resources, which in this case is the cogon grass. Likewise, the specific objectives of this research are as follows:

- To obtain the thermal conductivity (k-value) and thermal resistivity (R-value) values through Lee's Disc method.
- To determine the water absorption rate of the CGC roof tile.
- To identify the flammability rate of the CGC roof tile.
- To determine the physical properties of the CGC roof tile in terms of color, texture, and density.
- To compare the difference in performance rating and quality of the CGC roof tile against the commercially available concrete roof tile
- To identify the possible architectural building type applications of the CGC roof tile.

METHODOLOGY



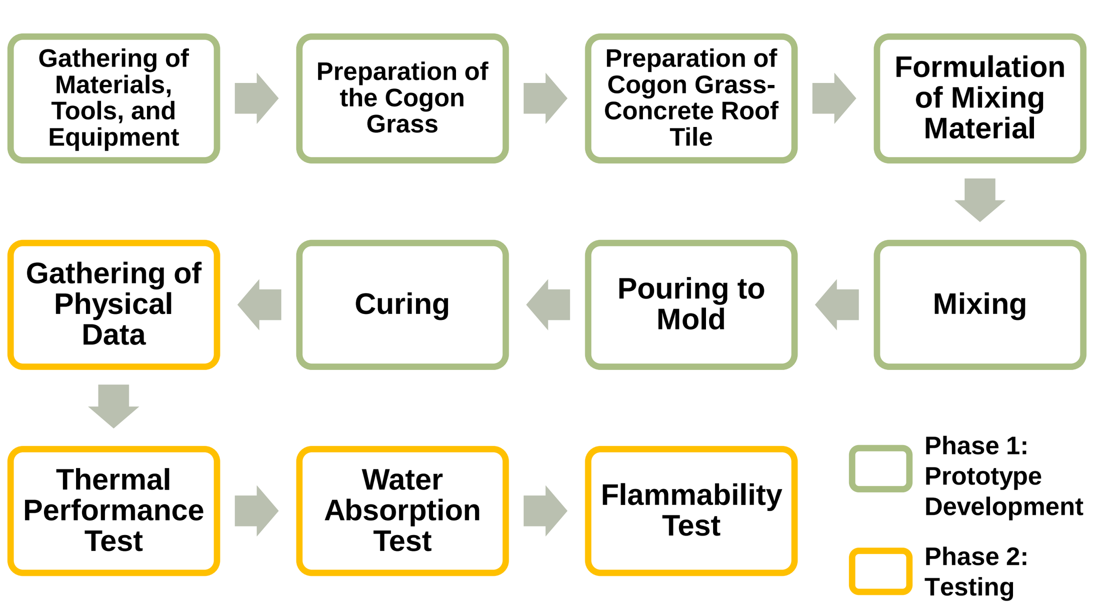


Figure 1. General Procedure

Materials, Equipment, and Experimental Procedure

Phase 1 and 2 of this study involved the prototype development and testing procedures, as discussed herein.

Phase 1: Prototype Development

A. Gathering of Materials, Tools, and Equipment

The table below lists the tools, materials, and equipment used in this study.

Table 1. Tools, Materials, and Equipment

Raw Materials	Tools	Equipment
Sun-dried Cogon grass	Scissors	Camera
Holcim Portland cement	Trowel	Laptop/Computer
Fine sand	Basin	
Clean water	Water bucket	
	Plastic sheets	**Thermal Conductivity Test**
Custom Steel Molds	Weighing scale	Lee's Disc Apparatus
6 in x 6 in x 10 mm square molds	Stopwatch	Heat gloves
6 in dia. circular molds	Measuring jug	Steel rack
2 in x 2 in x 2 in cube molds	Sand sifter	
		Compression Test
		Compression testing machine
		Flammability Test
		Bunsen burner with hose
		LPG tank
		Bunsen burner tripod

B. Preparation of the Cogon Grass

In this study, the researcher acquired an already sun-dried cogon grass from a supplier. Cut any unusable parts of the grass – those that are thicker than 2 mm. It will then be manually cut into 1 mm to 2 mm thickness and up to 3 mm width with 10 mm to 20 mm length size using scissors.

Figure 2. Cogon Grass Preparation

C. Preparation of Cogon Grass-Concrete Roof Tile

Prepare all necessary materials and tools for the production of the sample replicas.

Figure 3. Production Preparation

D. Formulation of Mixing Material

The following table shows the formulation of the material samples in this study:

Table 2. Formulation Sample of Proportional Mixing of the Cogon Grass-Concrete Roof Tile

Treatment	Formulation Sample	Concrete (% in ratio by volume)	Cogon Grass (% in ratio by volume)
Control	100% Concrete (100C)	100	0
Treatment 1 (T1)	10% Cogon 90% Concrete (10Co-90C)	90	10
Treatment 2 (T2)	20% Cogon 80% Concrete (20Co-80C)	80	20
Treatment 3 (T3)	30% Cogon and 70% Concrete (30Co-70C)	70	30

E. Mixing

Combine and mix the dry materials first, such as cement, sand, and cogon grass. Once evenly combined, pour the water, and mix into slurry. Make sure that everything is mixed consistently.

Figure 4. Mixing Process

F. Pouring to Mold

Samples for the water absorption and flammability tests have the mixture poured into 6 in. by 6 in. by 10 mm square molds. For the thermal conductivity test, circular molds with 6 in. diameter and 10 mm thickness were utilized. Finally, 2 in by 2 in cube molds were utilized for the compression test.

Figure 5. Pouring to Molds

G. Curing

The tile samples were placed in a bucket full of water vertically to make each tile lean on each other for another 24 hours – subjecting them to water curing. Then, samples were removed from the bucket with water after 24 hours. Remove the samples from the molds seven (7) days after the pouring. They will, then, be left to cure in the air for a maximum of 28 days under a cool shaded place. The tiles were sprinkled with water twice a day.

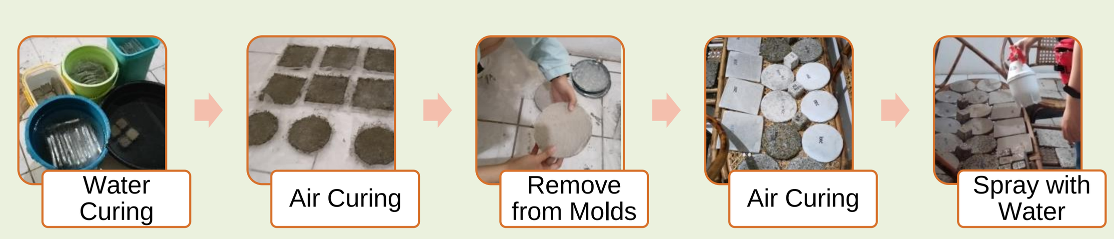


Figure 6. Curing Method

Phase 2: Experimental Process on the Series of Testing

A. Gathering of Physical Data

After curing, the roof tile samples were weighed using a weighing scale. This will obtain the mass or weight of samples. For the volume of the circular samples, the formula $V = \pi \times r^2 \times h$ was applied. For the area of circular samples, the formula $A = \pi \times r^2$ was used accordingly. Upon obtaining the mass and volume of the samples, the density formula was used to identify their respective densities. The color and texture were determined using observations accordingly.

B. Thermal Performance Test

The steady state temperature of the two carbon steel discs (D1 and D2) for each formulation sample replica were recorded and monitored to obtain the temperature difference.

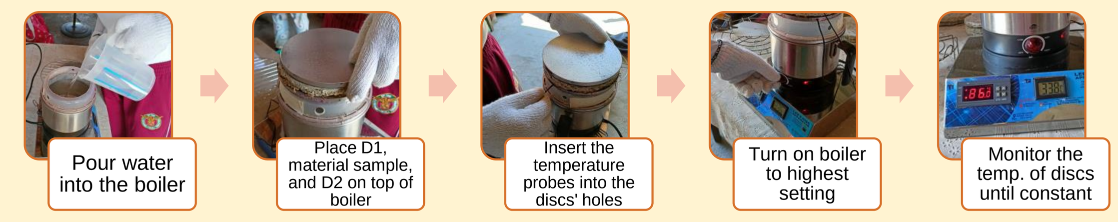


Figure 7. Identification of Steady State Temperatures

The temperature per minute of the Disc 2 (D2) when placed on the material sample were recorded for the computation of the rate of cooling.

Figure 8. Identification of Rate of Cooling

C. Compression Strength Test

Place the cube samples one by one on the sample holder of a compression testing machine and convert the resulting kN to N units to calculate the equivalent compressive strength

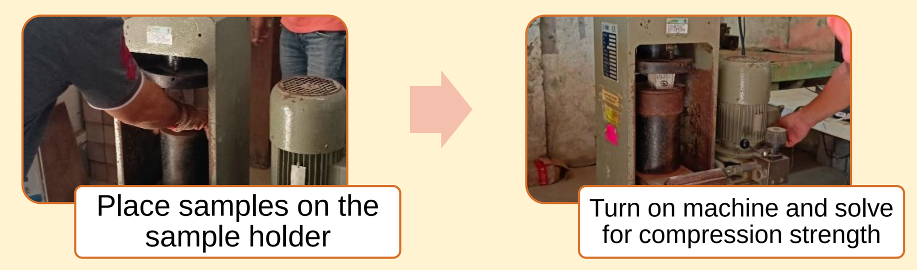


Figure 9. Compression Test Procedure

D. Water Absorption Test

The weight of the samples before and after submersion to water for 24 hours were recorded. These data were used for the calculation of water absorption rate.

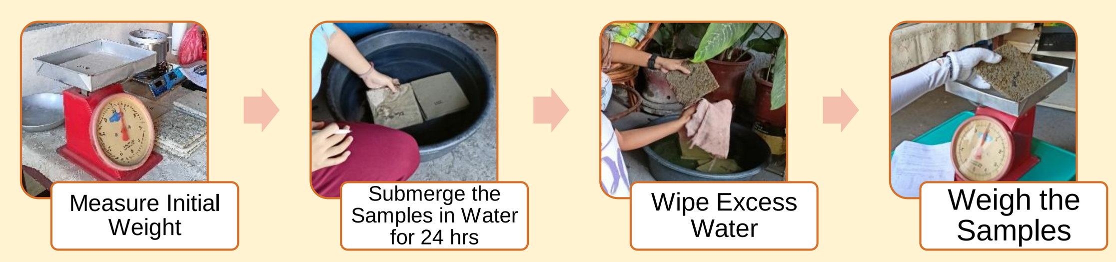


Figure 10. Water Absorption Test Procedure

E. Flammability Test

Each sample was subjected to a controlled fire using the Bunsen Burner for one hour, also called as the vertical flammability test.

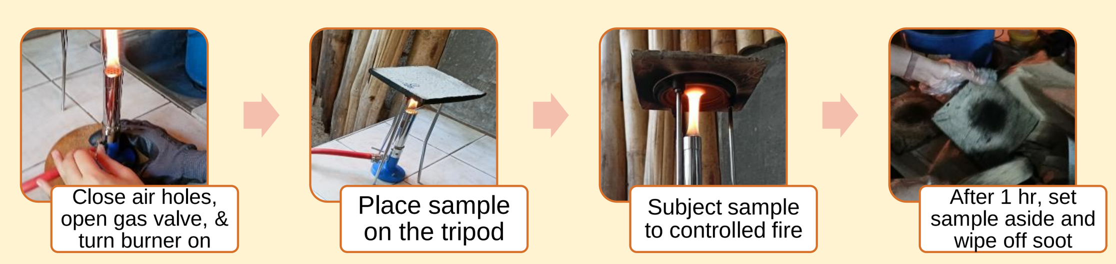


Figure 11. Flammability Test Procedure

Research Framework

This research was divided into four phases namely: (1) the prototype development, (2) the testing of prototype samples, (3) the analysis of results and data from the tests, and (4) identification of applicability of the newly made product.

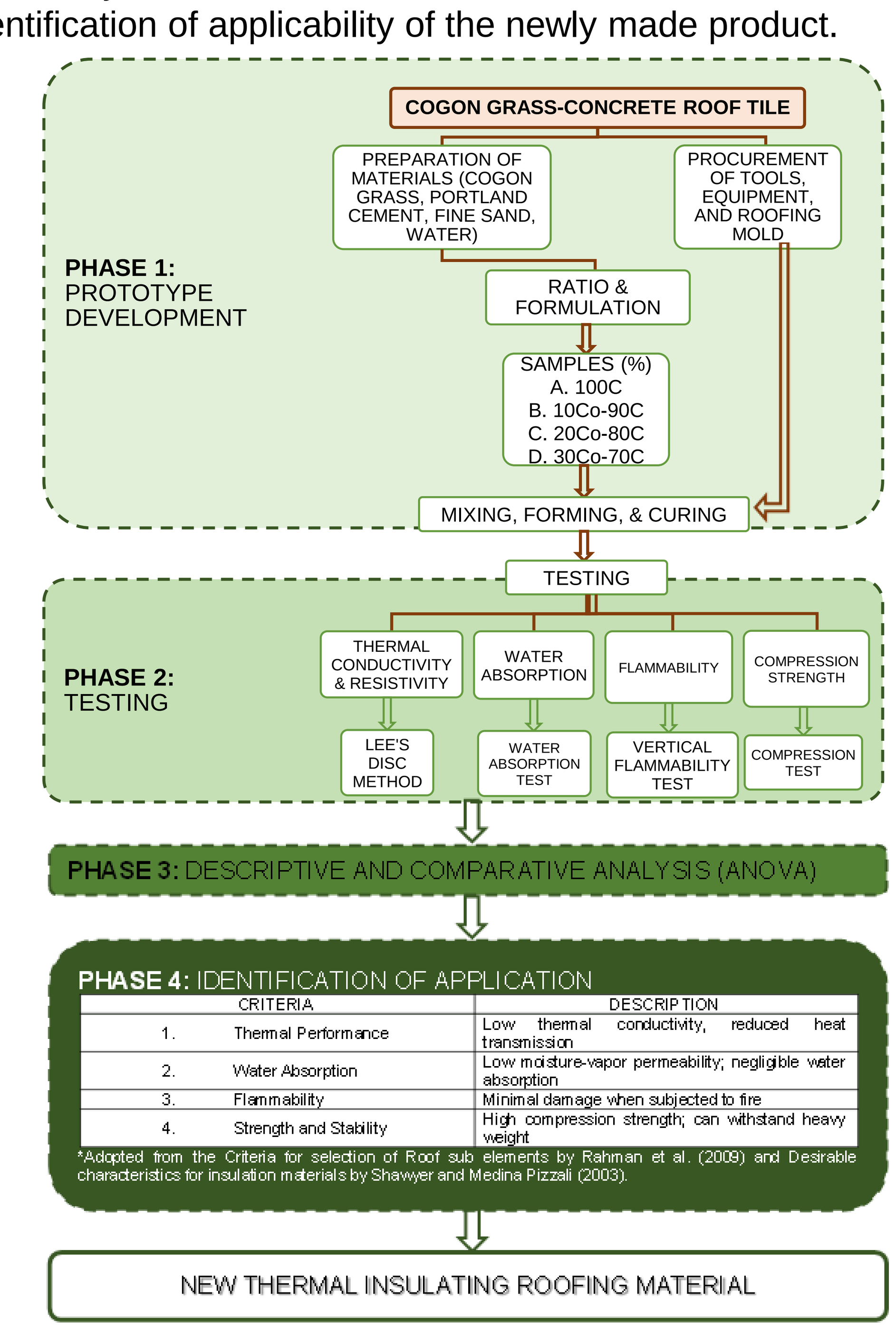


Figure 12. Research Framework

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ARCHITECTURAL DESIGN IX: RESEARCH PROJECT IN ARCHITECTURE

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RESULTS

Thermal Performance Test and Other Physical Data

The following table shows the measured physical data of the material sample and the carbon steel disc used for the thermal performance test.

Table 3. Physical Data of the Material Sample and the Carbon-Steel Disc

Formulation	Replica	Material Sample: Mass	Dia.	Thk.	Area	Volume	Density	Carbon Steel Disc: Mass	Dia.	Thk.	Area	Rate of Cooling	T1 Temp	T2 Temp	Temp. Diff
		(kg)	(m)	(m)	(m^2)	(m^3)	(kg/m^3)	(kg)	(m)	(m)	(m^2)		(°C)	(°C)	(°C)
Control	1	0.35	0.152	0.010	0.018	1.81E-04	1928.82	1.1	0.152	0.008	0.018	1.078	86.0	53.5	32.5
	2	0.45	0.152	0.010	0.018	1.81E-04	2479.91	1.1	0.152	0.008	0.018	0.921	86.0	51.2	34.8
	3	0.45	0.152	0.010	0.018	1.81E-04	2479.91	1.1	0.152	0.008	0.018	0.735	86.0	52.4	33.6
T1	1	0.55	0.152	0.013	0.018	2.36E-04	2331.54	1.1	0.152	0.008	0.018	0.399	86.0	44.6	41.4
	2	0.45	0.152	0.012	0.018	2.18E-04	2066.59	1.1	0.152	0.008	0.018	0.602	86.0	49.8	36.2
	3	0.55	0.152	0.011	0.018	2.00E-04	2755.45	1.1	0.152	0.008	0.018	0.359	86.0	44.6	41.4
T2	1	0.525	0.152	0.011	0.018	2.00E-04	2630.20	1.1	0.152	0.008	0.018	0.252	86.0	45.1	40.9
	2	0.45	0.152	0.015	0.018	2.72E-04	1653.27	1.1	0.152	0.008	0.018	0.475	86.0	48.0	38.0
	3	0.375	0.152	0.012	0.018	2.18E-04	1722.16	1.1	0.152	0.008	0.018	0.503	86.0	48.6	37.4
T3	1	0.5	0.152	0.014	0.018	2.54E-04	1968.18	1.1	0.152	0.008	0.018	0.282	86.0	42.0	44.0
	2	0.475	0.152	0.015	0.018	2.72E-04	1745.12	1.1	0.152	0.008	0.018	0.403	86.0	46.4	39.6
	3	0.625	0.152	0.013	0.018	2.36E-04	2649.47	1.1	0.152	0.008	0.018	0.321	86.0	44.8	41.2

Table 4. Rate of Cooling

Rate of Cooling (°C/minute)			
Formulation	Replica	(dT/dt)	Mean
Control	1	1.0782	0.8667
	2	0.9209	
	3	0.7352	
T1	1	0.3985	0.4495
	2	0.6018	
	3	0.3588	
T2	1	0.2518	0.3373
	2	0.4751	
	3	0.5025	
T3	1	0.2822	0.3343
	2	0.4031	
	3	0.3209	

Rate of Cooling

The rate of cooling was calculated by recording and plotting the temperature (°C) per minute. The formula y = mx + b was applied, where m is the slope of the line and further represents the rate of cooling.

The figure below shows how the temperature cools down per minute until it reaches 5°C below each steady state. Indicated as well are the trendline for each sample replicas – using the multi trendline function, the average rate of cooling was obtained as represented by the slope of the mean trendline. Slower rate of cooling signifies that the transfer of heat across the objects are slowed down which is a characteristic of a good insulator.

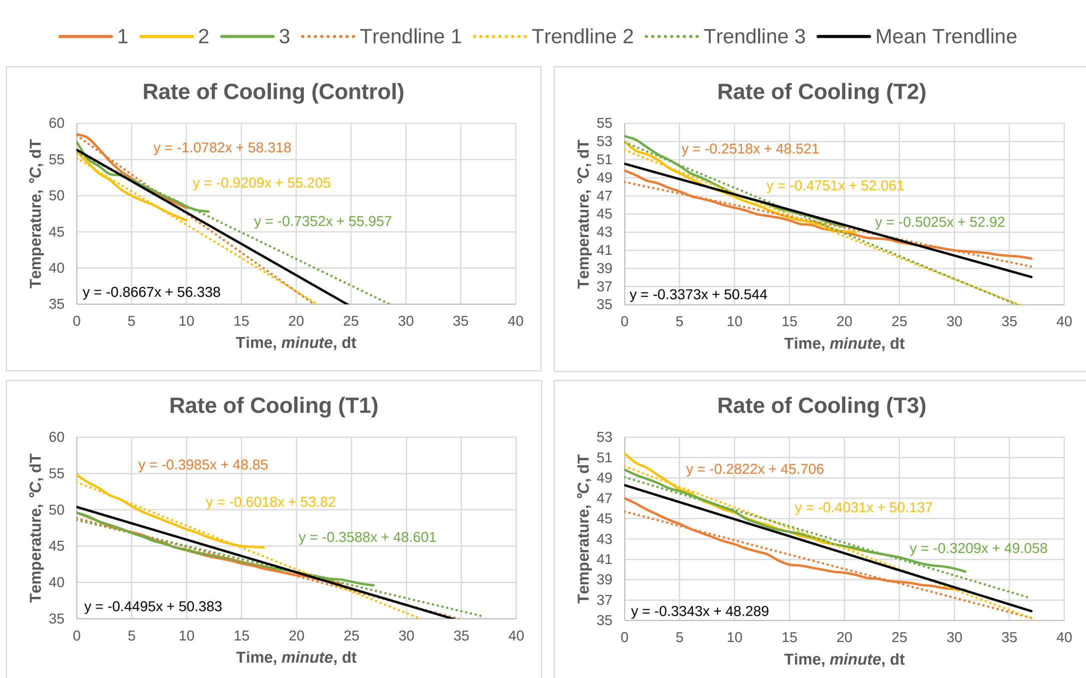


Figure 12. Rate of Cooling for Each Formulation

Thermal Conductivity (k-value) and Thermal Resistivity (R-value)

The table reveals the converted temperature difference of the samples (from °Celsius to Kelvin), and their thermal conductivity and resistivity. As observed, the higher thermal conductivity sample replicas have lesser thermal resistivity, and vice versa.

Table 5. Temperature Difference, k-value, and R-value

Formulation	Sample Replica	Converted Temp. Diff. to Kelvin	Thermal Conductivity	Thermal Conductivity Mean	Thermal Resistivity	Thermal Resistivity Mean
		(K)	(W/m-K)		(K-m/W)	
Control	1	305.65	8.595E-01	7.240E-01	1.163E-02	1.416E-02
	2	307.95	7.286E-01		1.372E-02	
	3	306.75	5.840E-01		1.712E-02	
T1	1	314.55	3.087E-01	3.535E-01	4.212E-02	3.567E-02
	2	309.35	4.740E-01		2.532E-02	
	3	314.55	2.779E-01		3.958E-02	
T2	1	314.05	1.954E-01	3.205E-01	5.631E-02	4.235E-02
	2	311.15	3.720E-01		4.032E-02	
	3	310.55	3.942E-01		3.044E-02	
T3	1	317.15	2.168E-01	2.599E-01	6.458E-02	5.487E-02
	2	312.75	3.140E-01		4.777E-02	
	3	314.35	2.487E-01		5.227E-02	

It was known that the control sample has the highest thermal conductivity or k-value with a mean of 7.240E-01 W/m-K, while the Treatment 3 (T3) or the formulation with 30% cogon and 70% concrete yields the lowest thermal conductivity with a 2.599E-01 W/m-K – indicating an inversely proportional results with its thermal resistivity. Furthermore, the average thermal conductivity of Treatment 1 is 3.535E-01 W/m-K, and Treatment 2 has 3.205E-01 W/m-K.

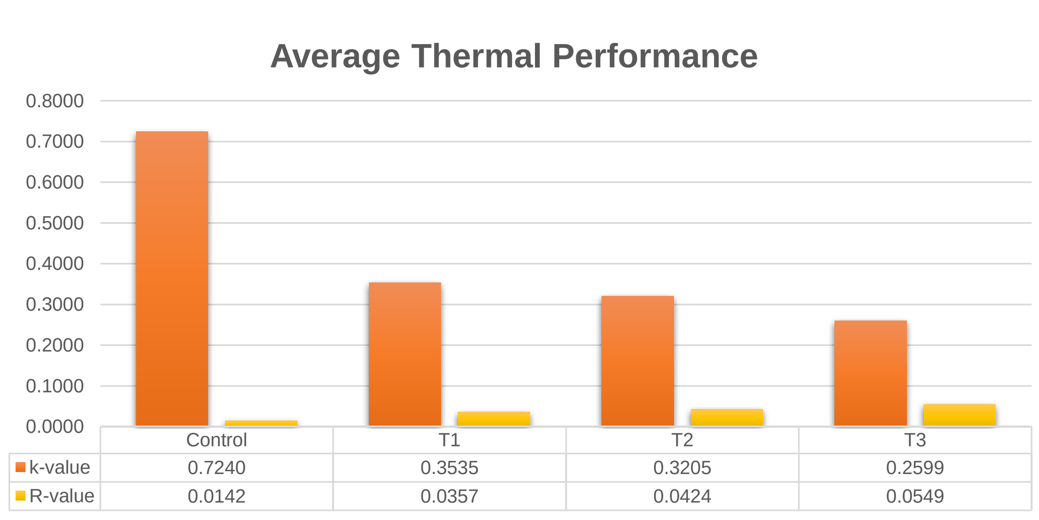


Figure 13. Thermal Performance among Formulations

Compression Strength Test

Below presents measured and calculated data from the compression test after the 28-day curing.

Table 6. Compressive Strength Capacity Results

Formulation	Sample	Applied Force	Equivalent Compressive Strength		Mean		Results
		(N)	(MPa)	(psi)	(MPa)	(psi)	(≥ 4 N/mm2)
Control	1	14970.00	5.801	841.35	10.236	1484.7	PASSED
	2	37330.00	14.465	2098.03			
	3	26950.00	10.443	1514.65			
T1	1	12080.00	4.681	678.92	4.774	692.41	PASSED
	2	12250.00	4.747	688.48			
	3	12630.00	4.894	709.84			
T2	1	8640.00	3.348	3.35	3.8879	563.9	FAILED
	2	11400.00	4.418	4.42			
	3	10060.00	3.898	3.90			
T3	1	8370.00	3.243	3.24	3.4048	493.83	FAILED
	2	7650.00	2.964	2.96			
	3	10340.00	4.007	4.01			

Water Absorption Test

The table below presents the initial and final weight of the samples after submerging them in water for 24 hours, and their computed water absorption rate.

Table 7. Water Absorption Results

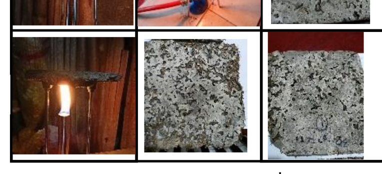
Formulation	Sample	Initial Weight	Final Weight	Water Absorption Rate	Mean	Results
		(g)	(g)	(M%)	(M%)	(< 10%)
Control	1	500	510	2.00%	2.67%	PASSED
	2	495	500	1.01%		
	3	500	525	5.00%		
T1	1	775	800	3.23%	5.07%	PASSED
	2	725	760	4.83%		
	3	700	750	7.14%		
T2	1	575	600	4.35%	5.51%	PASSED
	2	600	650	8.33%		
	3	650	675	3.85%		
T3	1	475	500	5.26%	5.68%	PASSED
	2	425	450	5.88%		
	3	425	450	5.88%		

The maximum water absorption rate for concrete roof tile is 10%. All the formulation samples passed the standard as the control sample has an average of 2.67% which is the lowest, Treatment 1 with 5.07%, Treatment 2 with 5.51%, and Treatment 3 with 5.68% which is the highest among all formulations.

Flammability Test

Below shows the summarized results for the vertical flammability test. All the roof tile samples were non-flammable. No significant amount of smoke was observed during and after the test.

Table 8. Flammability Test Results

Photos	Formulation	Sample	Smolders	Flammable	Smoke
	Control	1*	✓	x	x
		2	✓	x	x
		3	✓	x	x
	T1	1	✓	x	x
		2	✓	x	x
		3	✓	x	x
	T2	1	✓	x	x
		2	✓	x	x
		3	✓	x	x
	T3	1	✓	x	x
		2	✓	x	x
		3	✓	x	x

* = sample was broken and cracked after test

Physical Characteristics

The table below describes the color and texture of each sample with its corresponding formulation.

Table 9. Summary of Physical Characteristics of the Formulation Samples

Photos	Formulation Sample	Color	Texture & Other Remarks
	Control	Light gray in color	Smooth; no honeycomb
	T1	Light, white-grayish color	Little fibers are showing; smooth but rougher than control sample
	T2	Darker than T1; light to dark gray color; uneven color patches	More fibers are visible; quite smooth but a bit rough due to more honeycomb; sides are easy to chop off
	T3	Dark gray color	Very visible fibers; rough due to fibers and honeycomb; very fragile; lots of honeycomb; sides easily crumble

The relationship between density and thermal conductivity (k-value) with the three samples of each formulation are presented by Table 9. As stated from the study of Khouki and Tahat (2015), the material density is inversely proportional to thermal conductivity: the higher the k-value, the lower the density, and vice versa. When the three individual samples of a formulation are compared, it can be noted that most samples exhibited such characteristics.

Table 10. Density vs Thermal Conductivity (k-value)

Formulation	Sample	Density	k-value
		(kg/m^3)	(W/m-K)
Control	1	1928.82	0.58607
	2	2479.91	0.58169
	3	2479.91	0.58396
T1	1	2331.54	0.30868
	2	2066.59	0.31387
	3	2755.45	0.30868
T2	1	2630.20	0.19535
	2	1653.27	0.19717
	3	1722.16	0.19756
T3	1	1968.18	0.24653
	2	1745.12	0.25000
	3	2649.47	0.24873

Performance Rating and Quality of Cogon Grass-Concrete (CGC) Roof Tile vs Commercially Available Roof Tiles

The average thermal conductivity (k-value) of the formulations were compared to the k-value of commercially available roofing materials. Arranged from lowest to highest thermal conductivity,

Table 11. Thermal Conductivity of CGC Roof Tile vs Commercial Roofing

Material	k-value (W/m-K)
30Cog-70C Roof Tile (T3)	0.26
20Cog-80C Roof Tile (T2)	0.32
10Cog-90C Roof Tile (T1)	0.35
Compressed Earth Roof (Koumbem et al.)	0.66
Control Concrete Roof Tile	0.72
Terracotta Roof Tile (Koumbem et al.)	0.80
Concrete Roof Tile (commercial; Greenspec)	0.84
Clay Tiles (Greenspec)	0.85
Reconstituted Slates (Greenspec)	1.50
Natural Slate (Greenspec)	2.50

DISCUSSION

Thermal Performance

The experimentation and test results revealed that the addition of cogon grass as an admixture to concrete roof tiles exhibited positive results in terms of the thermal performance with lowered thermal conductivity (k-value) and a higher thermal resistivity (R-value). In terms of rate of cooling, the material sample served as an insulator to reduce the flow of heat in and out of the disc. Slower heat flow indicates good thermal insulation of the material sample. As presented in Figure 12, a greater amount of cogon slows down the transfer of heat from one object to another. Moreover, the sample with 10% cogon demonstrated about twice as much time it took the control sample to cool down.

Compressive Strength Capacity

The average compressive strength capacity of the 10% cogon and 90% concrete formulation samples was 4.77 MPa. The applied force for samples with 20% and 30% cogon were 3.89 MPa and 3.40 MPa respectively, both of which failed the standard for compressive strength. The tiles became more fragile as the percentage of cogon increases.

Water Absorption

As the amount of cogon admixture increases, so does the water absorption rate of the roof tiles. Nevertheless, passing the standard mark for water absorption rate indicates that the proposed Cogon Grass-Concrete Roof Tiles are viable to use in construction. Identifying the water absorption rate of the roof tiles aids in the structural analysis for the roof.

Flammability

No significant smoke and flame were present when all the samples were subjected to vertical flammability test for an hour, all samples, regardless of formulation, are classified to be incombustible. Only smolders and soot are present during and after the test. The only notable observation of the results of the fire is the breakage of one of the control samples after the test. With these, it is proven that the use of cogon grass as an admixture to concrete roof tile does not bring adverse effects when subjected to fire.

Color, Texture, and Density

As shown in Table 8, the color and texture of each formulation sample are described. Among the three samples with cogon as an admixture, the 10% cogon and 90% concrete samples were the lightest in color, the smoothest, and had the least amount of honeycomb. The most fragile and easy to break when handled is the 30% cogon and 70% concrete formulation – showing very visible fibers and honeycomb, as well as easy to break sides and corners. The presence of honeycomb is due to the air bubbles when molding the mixture as the production did not make use of a machine for such task, and only manual production was involved.

Performance Rating of CGC Roof Tile vs Commercially Available Roof Tiles

Table 11 reveals that the addition of cogon grass as admixture considerably lowers the thermal conductivity of the material, adding a good thermal insulation property.

CONCLUSION

Through the results and analyses, it was concluded that Cogon Grass-Concrete (CGC) Roof Tile can replace concrete roof tiles, as well as other roofing materials such as clay and natural slate tiles, without additional building materials for heat insulation, while passing the standards for concrete roof tiles. It can be applied to the construction of residential buildings, institutional buildings, and commercial buildings such as retail stores and resorts – specifically those situated in areas that have greater need for heat insulation to achieve thermal comfort, particularly in tropical areas.

Table11. Summarized Assessment of CGC Roof Tile

Formulation	Thermal Performance	Compressive Strength	Water Absorption	Flammability
Conditions:	Low k-value	> 4 MPa	<10%	Incombustible
10% Cogon & 90% Concrete	✓	✓	✓	✓
20% Cogon & 80% Concrete	✓	x	✓	✓
30% Cogon & 70% Concrete	✓	x	✓	✓

RECOMMENDATIONS

For replication and production:

- The recommended formulation among the proposed percentage of cogon grass in this study is the 10% cogon grass and 90% concrete (Treatment 1).
- Mechanize the production or process, such as using machines that compacts and removes air in the slurry during the molding process

For future research:

- Testing of the CGC roof tile in terms of impact strength, flexural strength, water permeability, and freeze thaw to identify further uses and mechanical properties of the material
- Study on other percentage of cogon as admixture aside from 10%, 20%, and 30%.
- Exploration of thermal transmittance and configuration of the CGC Roof Tiles

Potential Projects:

- Low to mid-rise resorts, especially those located in coastal and tropical areas or areas with high heat index
- Other residential, commercial, and institutional buildings

Installation:

- Typical installation for concrete roof tiles is recommended: a flat interlocking roof tile with cross-bonded laying method provided below is an example for a typical installation of the CGC Roof Tile.

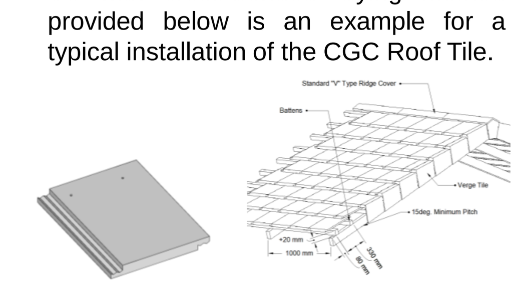


Figure 14. Interlocking Flat Concrete Roof Tile and Sample Installation (left to right)

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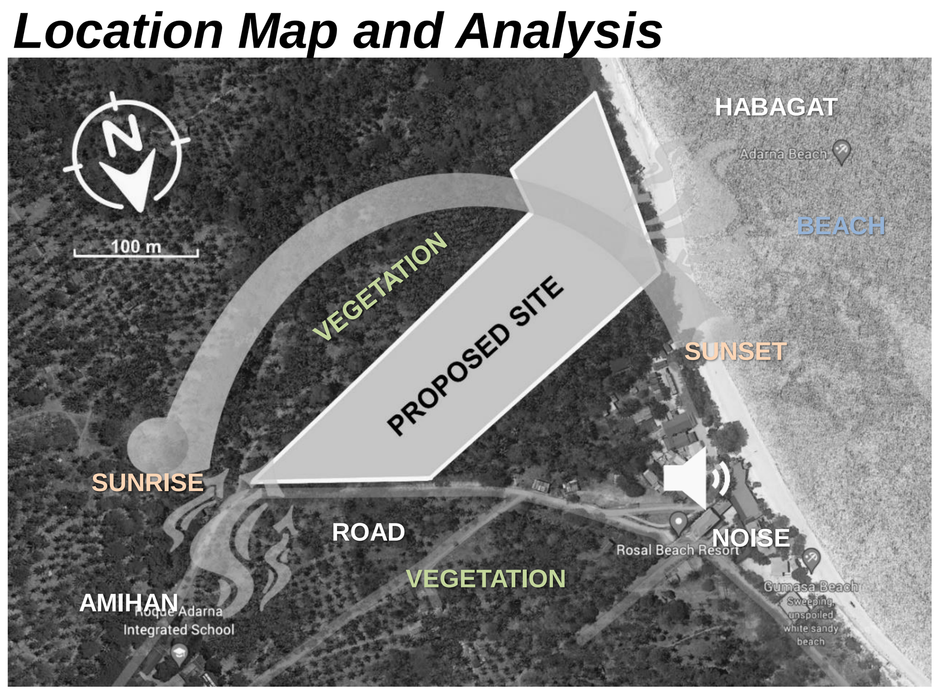
Lubi de Bay SEASIDE RESORT AND CONVENTION HOTEL

The PROJECT

Lubi de Bay Seaside Resort and Convention Hotel is a tourism-based development situated in a 3.4-hectare land along the beachfront of Glan, Sarangani. The whole development is composed of a mid-rise hotel, along with an event's place, beach cottages, an outdoor café and resto, and a separate employee's quarters building, all of which made use of the Cogon Grass-Concrete Roof Tile. The amenities of the project also include a pool with spa, a water sports facility, basketball court and open activity spaces, gazebos, outdoor bazaar, and guardhouses at the service and main entrance.

Named after the Cebuano words "*lubi*" for coconut and "*bay*" from the word *"baybayon"* for beach, Lubi de Bay, or "coconut of the beach," is a proposed seaside resort and convention hotel that aims to boost the tourism industry of the municipality and the region, creating jobs and opportunities, as well as contribute to the economy of Mindanao.

Location Map and Analysis



DESIGN CONCEPT

Focusing on giving the utmost thermal comfort to users while minimizing artificial ventilation, buildings were designed with tropical design solutions in mind. Philippine vernacular design, such as the bahay kubo and bahay na bato, shall also be incorporated in the design as the project, creating a unique identity that represents the municipality and the region.

Since Glan, Sarangani, the proposed site, has the abundance of coconut trees, being known as the "Coco Queen of the South," and the oldest town in South-Central Mindanao, the feeling of being under the coconut trees were exhibited in the interiors and structure of the buildings through abstract representation of coconuts using patterns and geometry.

DESIGN PHILOSOPHY

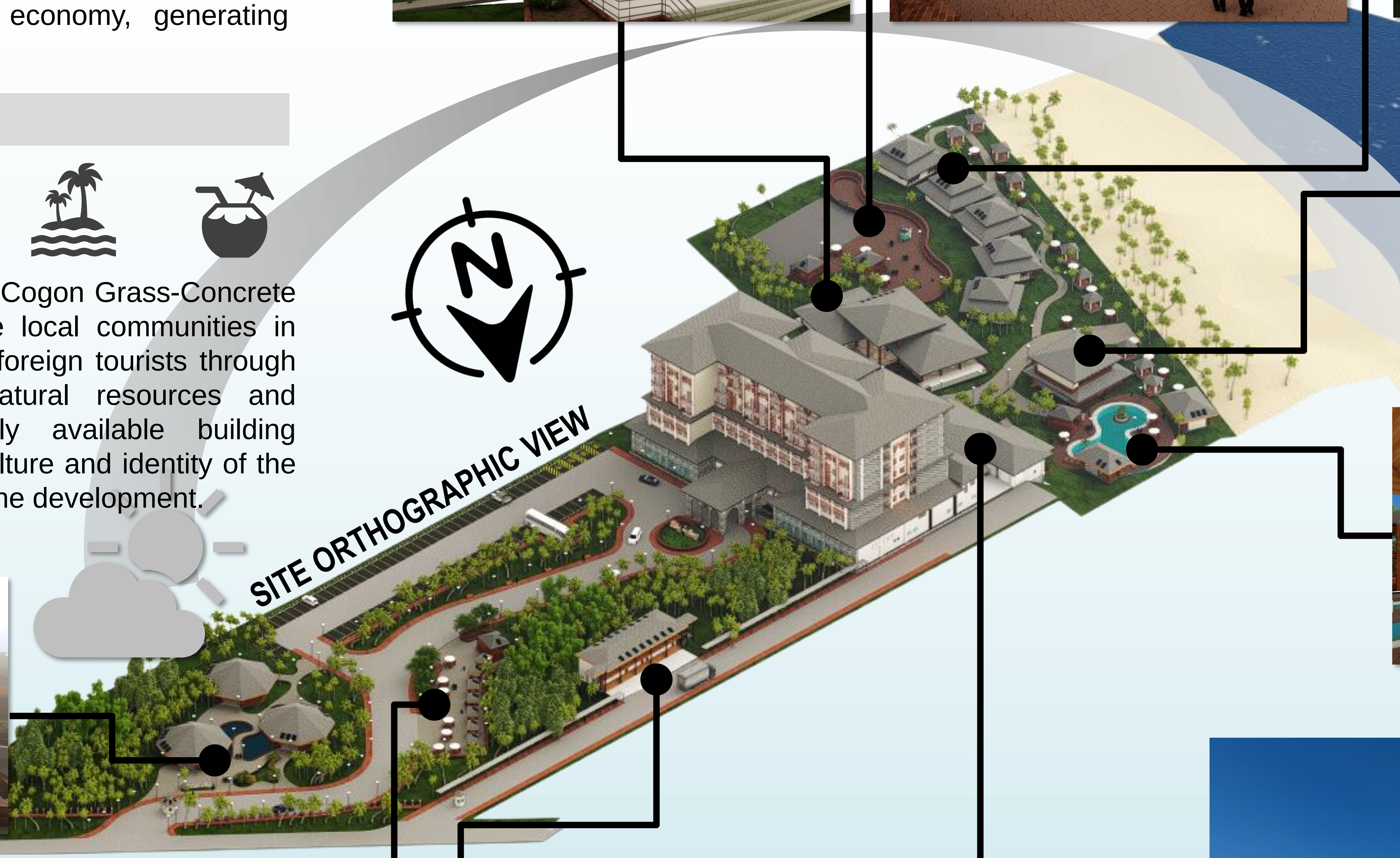
EXPERIENCE · SUSTAINABILITY · AESTHETIC ARCHITECTURE · THERMAL COMFORT · VERNACULAR DESIGN · COCONUT

VISION

The Proposed Seaside Resort's Vision is to elevate the tourism industry of the white sand beaches in Glan, Sarangani by attracting investors and tourists. This project shall boost SOCCSKSARGEN's economy, generating jobs and attracting investments.

MISSION

This project aims to introduce the Cogon Grass-Concrete Tile as a roofing material to the local communities in Mindanao and draw in local and foreign tourists through architecture and Mindanao's natural resources and environment by utilizing locally available building materials and incorporating the culture and identity of the place into the design elements of the development.



EVENT'S PLACE PAVILION

OPEN ACTIVITY SPACES

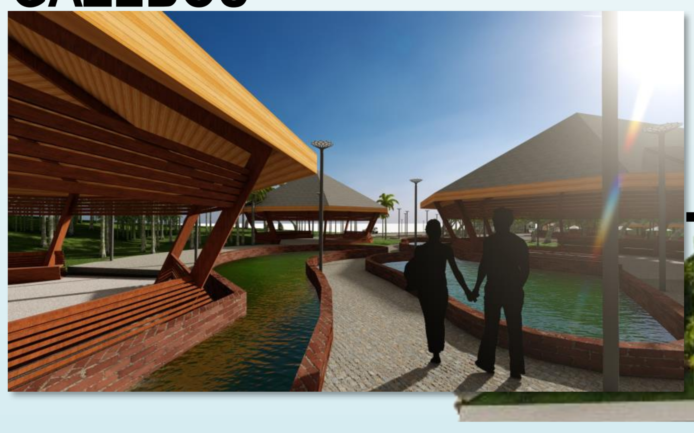
BEACH COTTAGES

CAFÉ & RESTO BAR

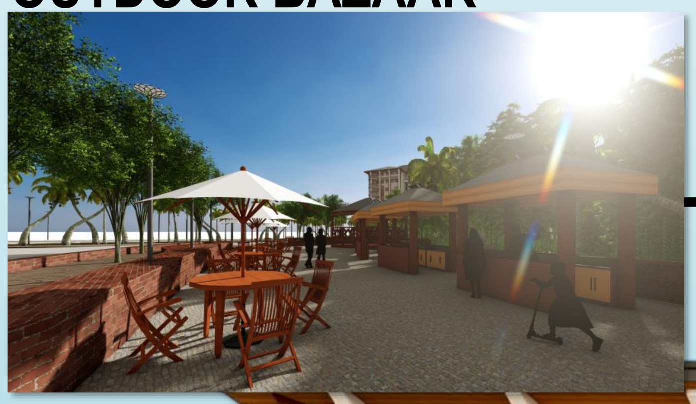
SPA, POOL, & WATER SPORTS

HOTEL

GAZEBOS



OUTDOOR BAZAAR



EMPLOYEES' QUARTERS

UNIVERSITY OF THE PHILIPPINES MINDANAO
DEPARTMENT OF ARCHITECTURE
BS ARCHITECTURE PROGRAM

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ARCHITECTURAL DESIGN IX: RESEARCH PROJECT IN ARCHITECTURE

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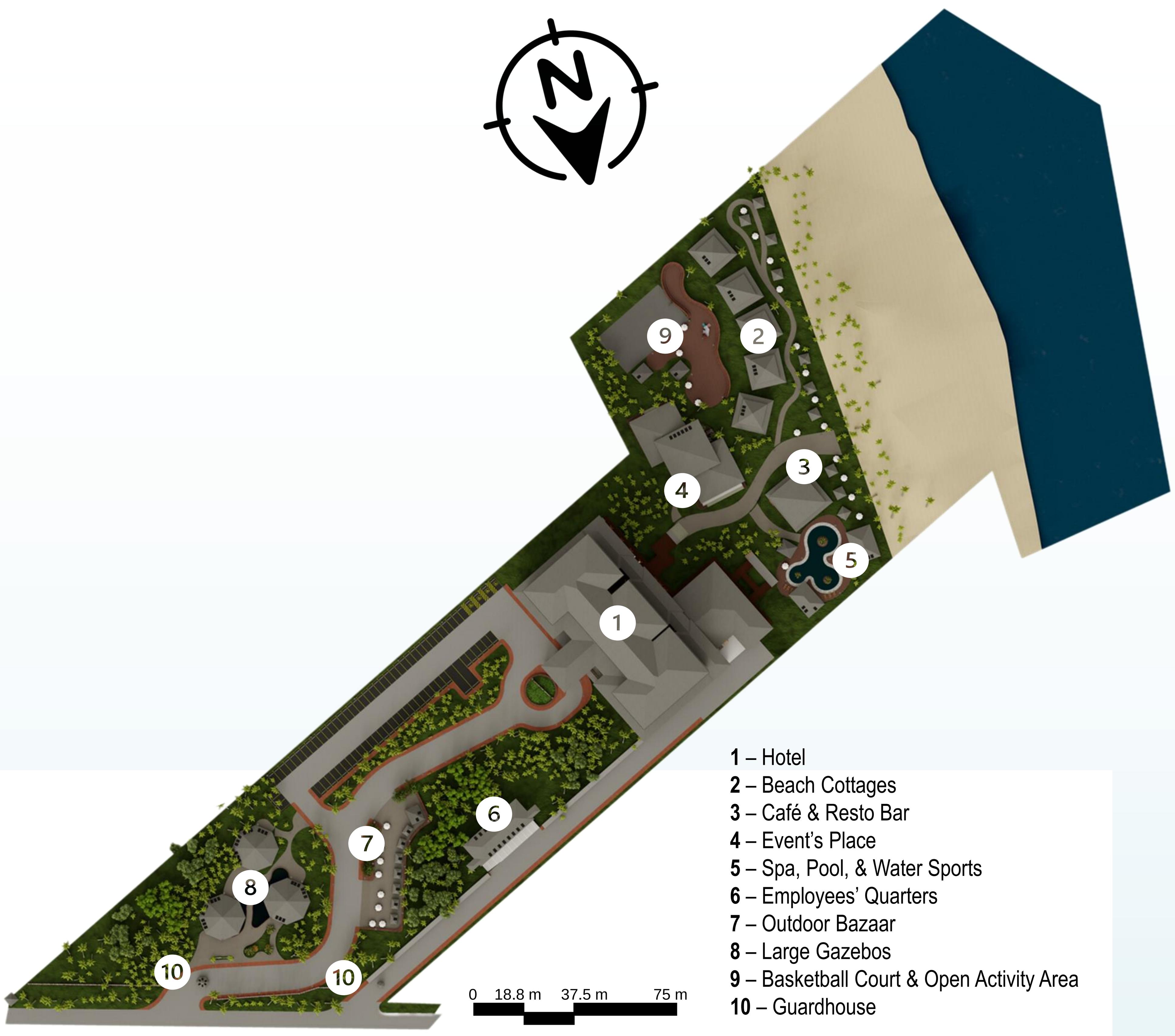
BOARD NUMBER

A01

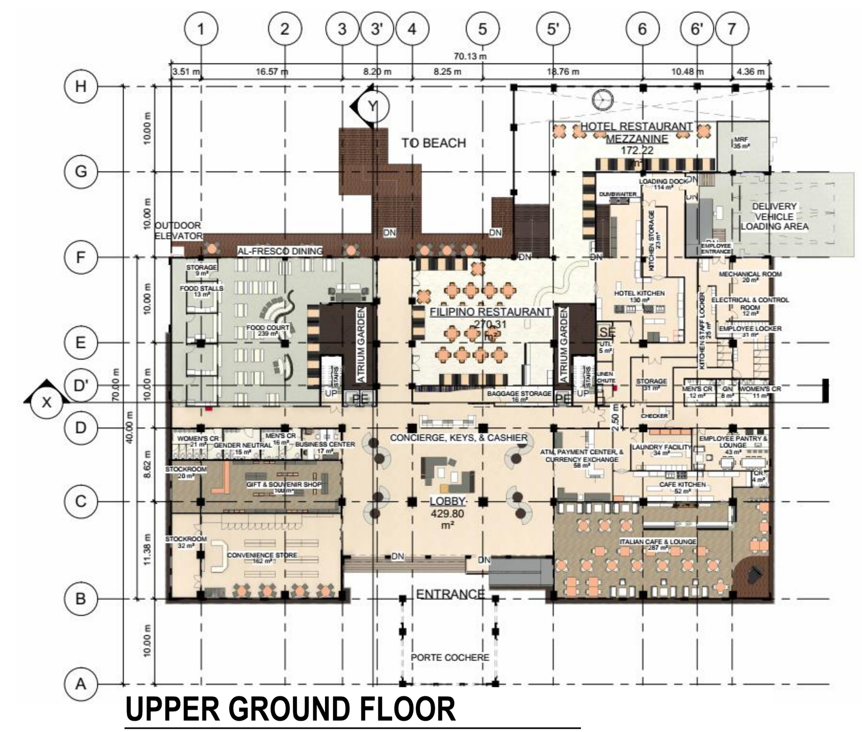
Lubi de Bay SEASIDE RESORT AND CONVENTION HOTEL

SITE DEVELOPMENT PLAN



1 – Hotel
2 – Beach Cottages
3 – Café & Resto Bar
4 – Event's Place
5 – Spa, Pool, & Water Sports
6 – Employees' Quarters
7 – Outdoor Bazaar
8 – Large Gazebos
9 – Basketball Court & Open Activity Area
10 – Guardhouse

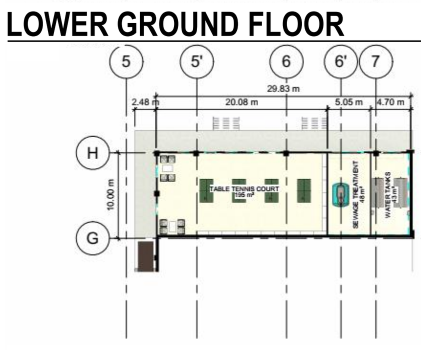
HOTEL FLOOR PLANS



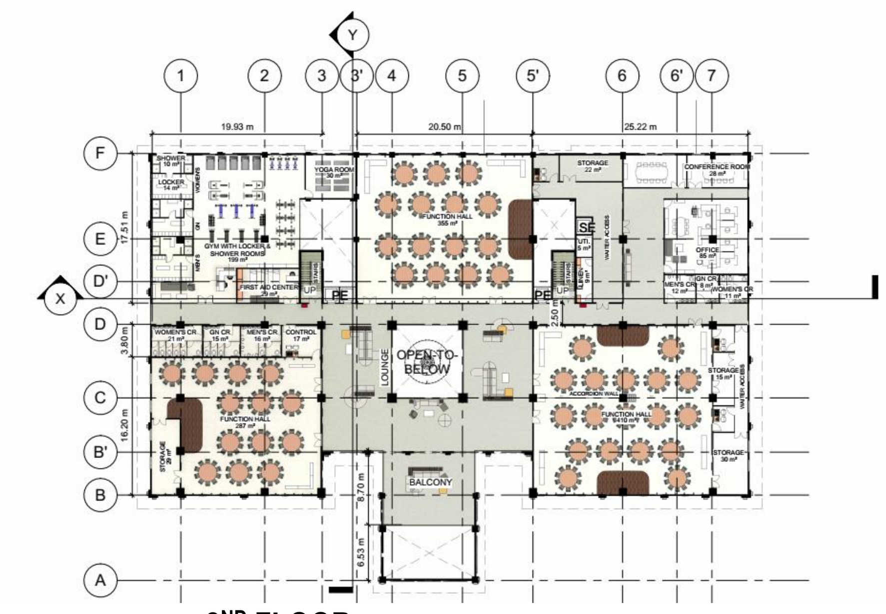
UPPER GROUND FLOOR

LOWER GROUND FLOOR

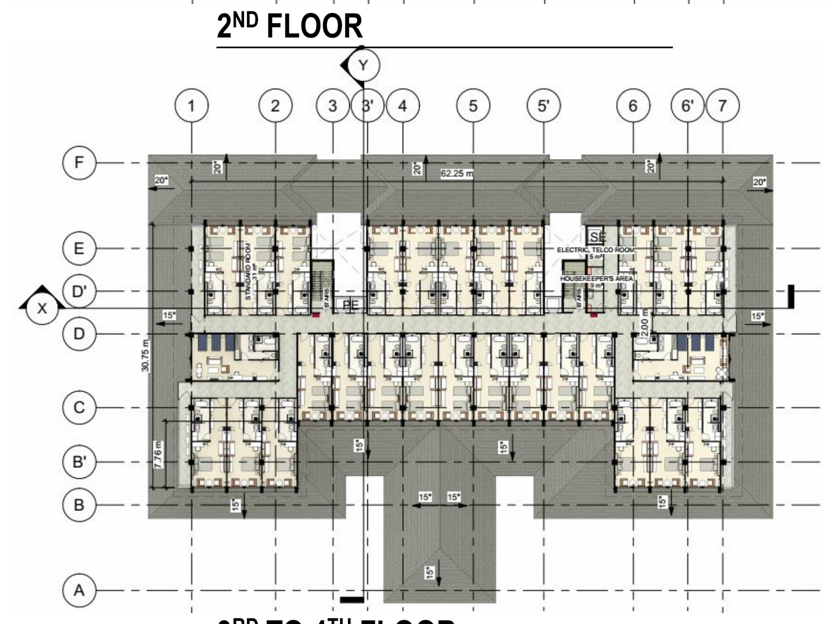
2ND LOWER GROUND FLOOR



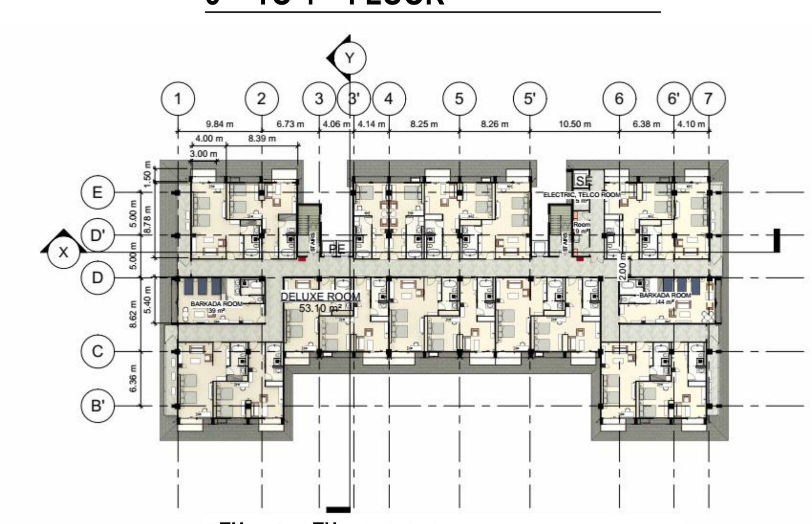
3RD LOWER GROUND FLOOR



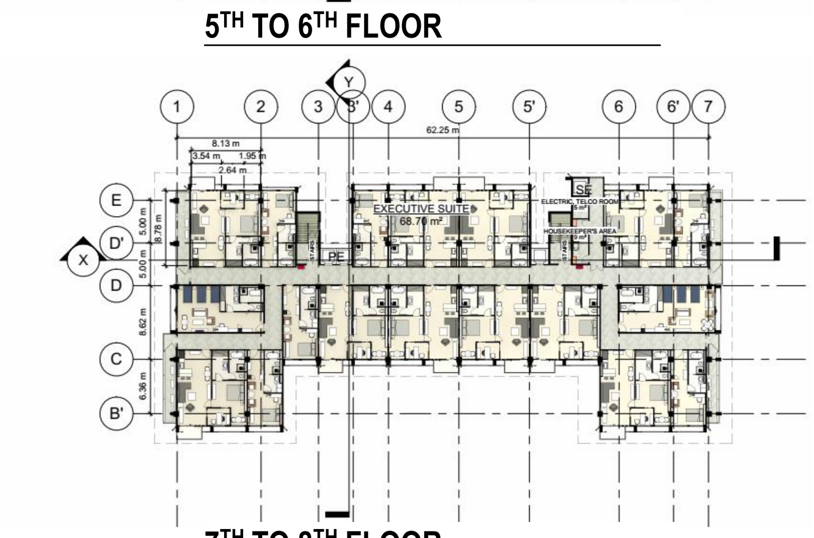
2ND FLOOR



3RD TO 4TH FLOOR

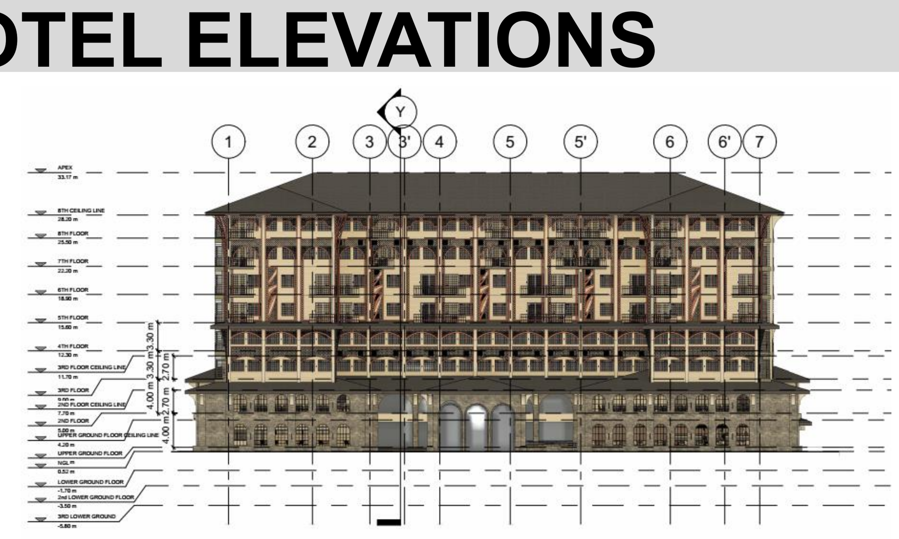


5TH TO 6TH FLOOR

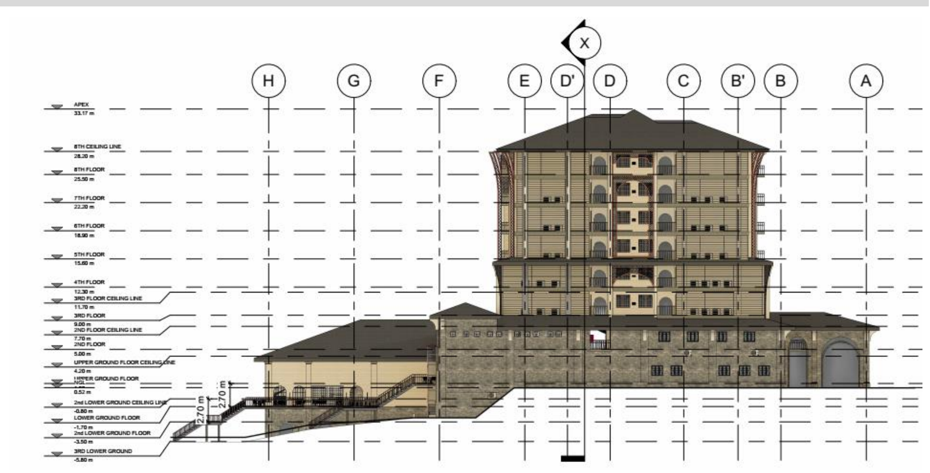


7TH TO 8TH FLOOR

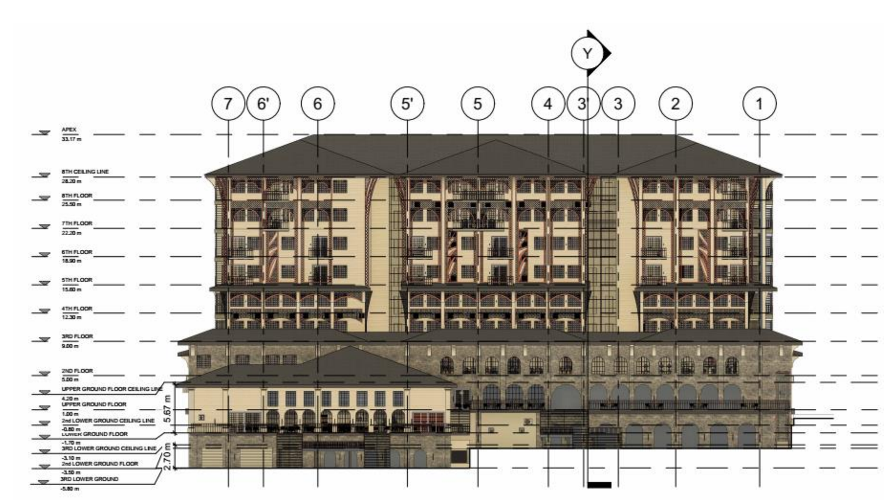
HOTEL ELEVATIONS



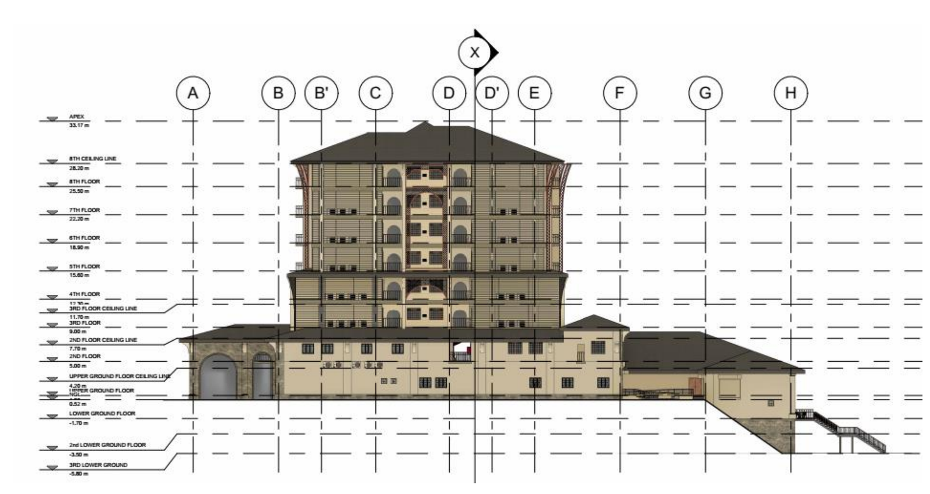
FRONT ELEVATION



LEFT SIDE ELEVATION

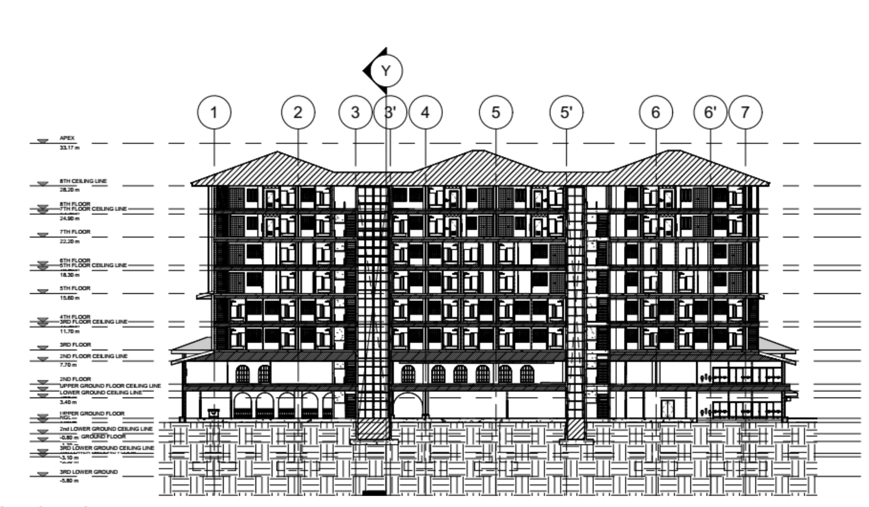


REAR ELEVATION

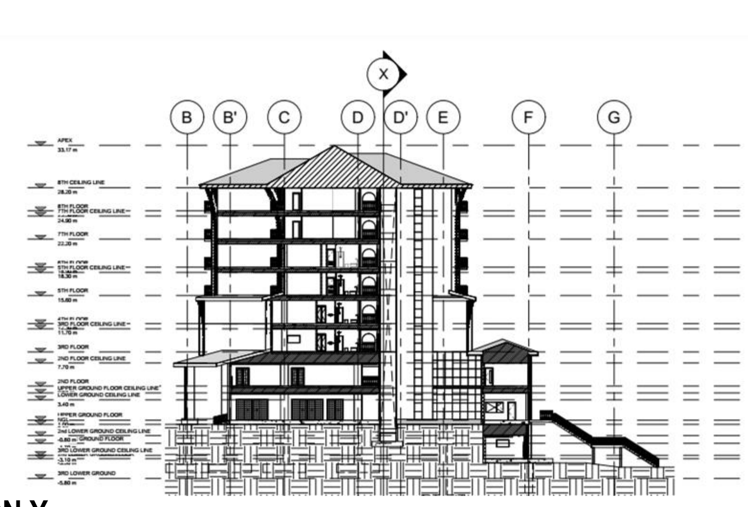


RIGHT SIDE ELEVATION

HOTEL SECTIONS



SECTION X



SECTION Y

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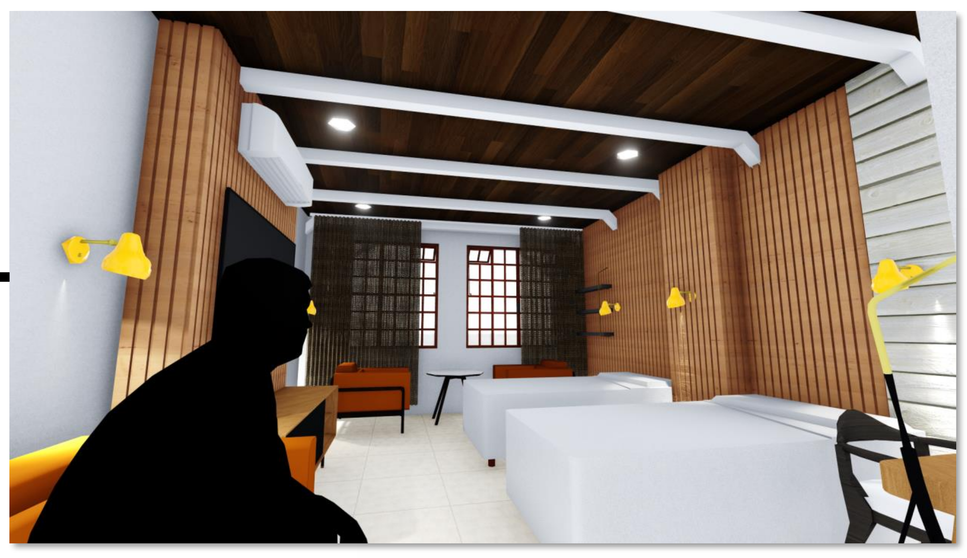
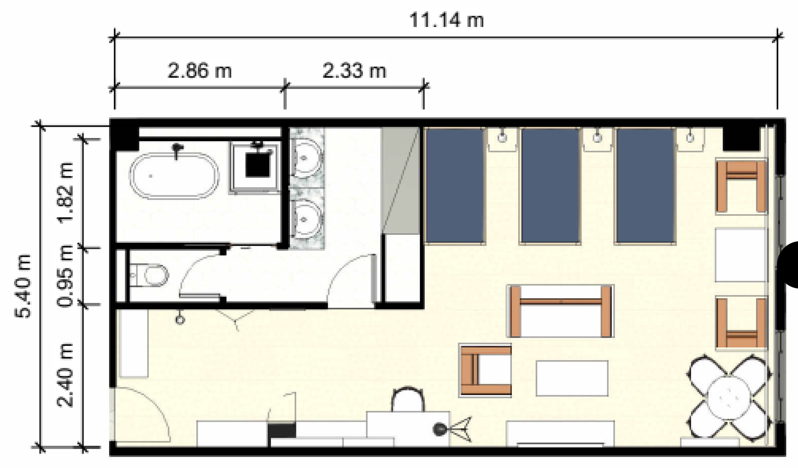
HOTEL ROOMS

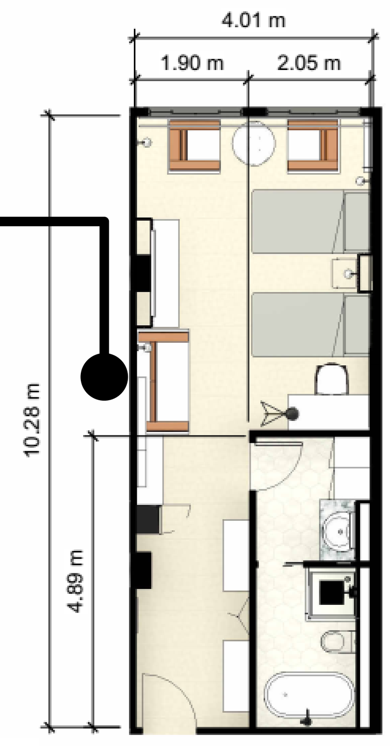
STANDARD ROOM



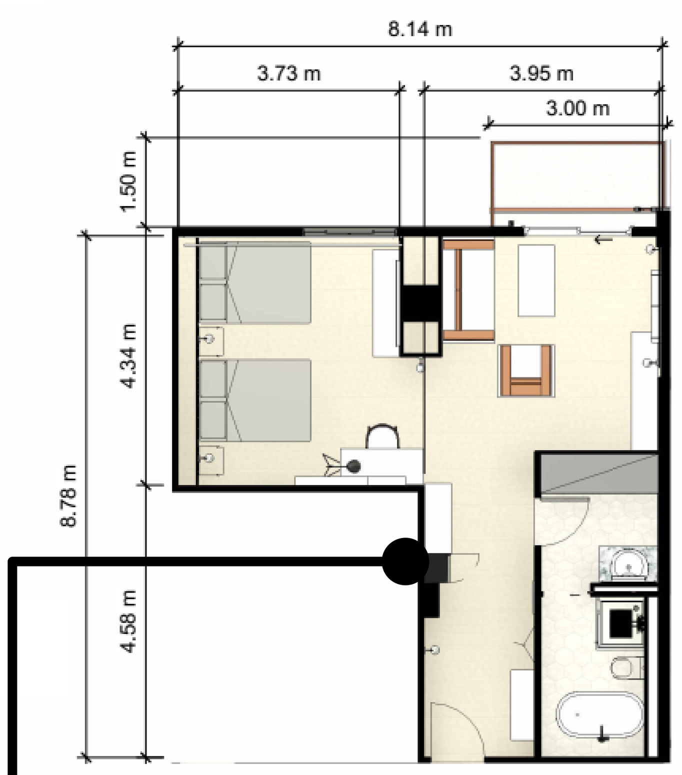
BARKADA ROOM



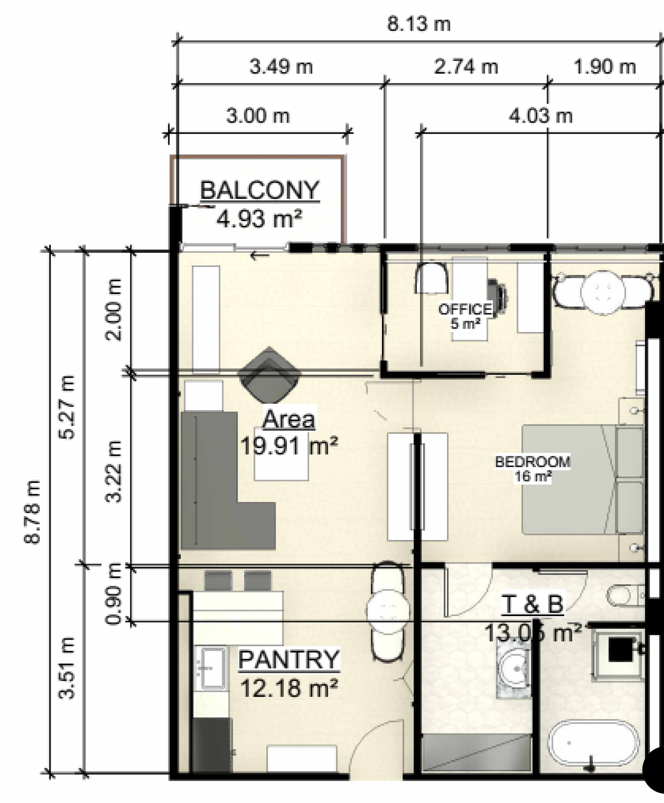
BARKADA ROOM



STANDARD ROOM

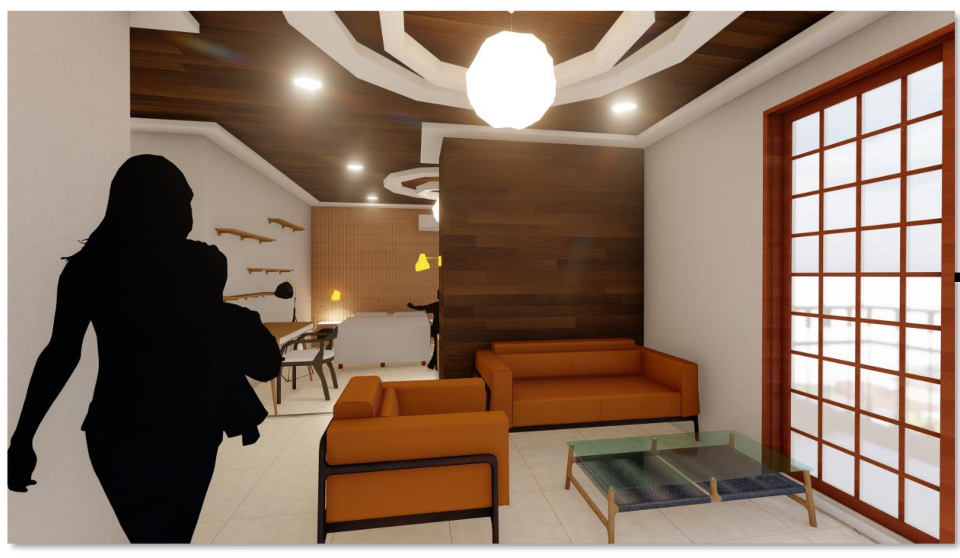


DELUXE ROOM

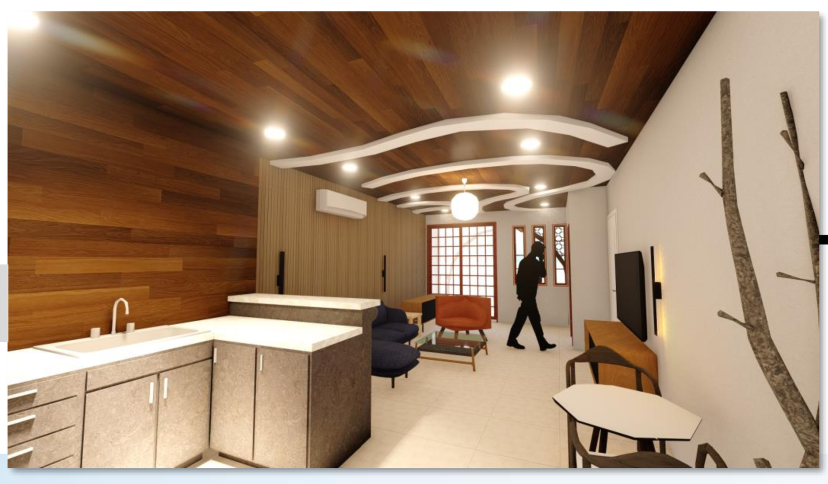


EXECUTIVE SUITE

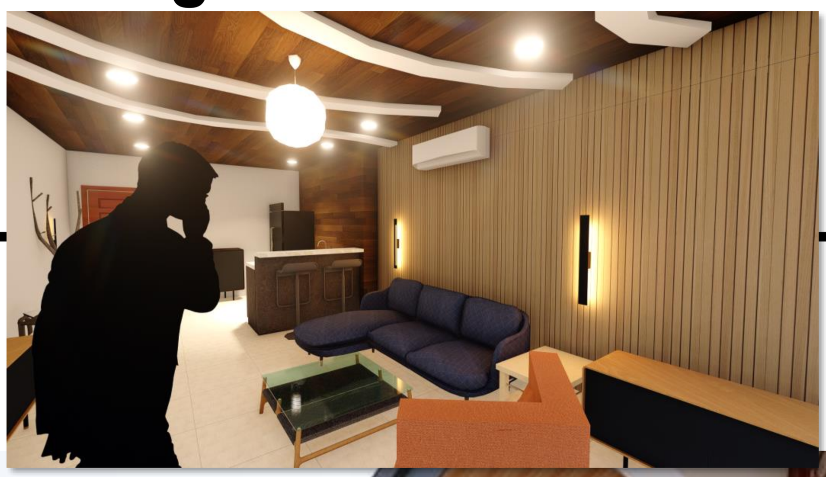
DELUXE ROOM



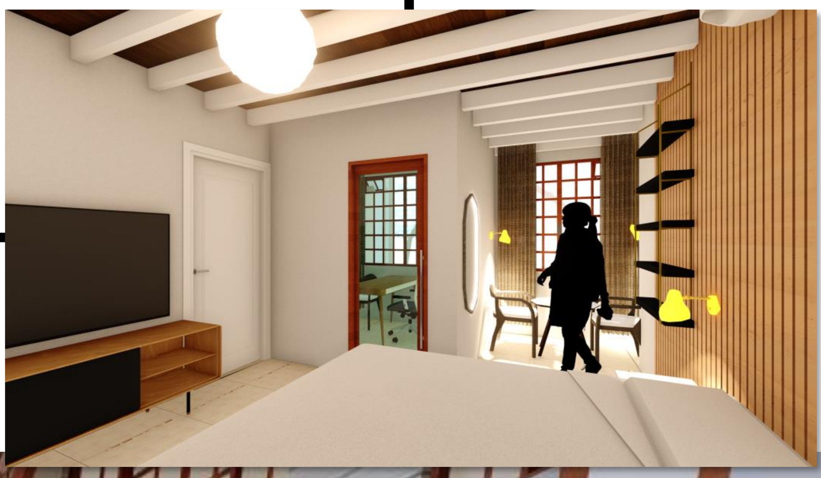
EXECUTIVE SUITE



Living Area



Bedroom



HOTEL INTERIORS

LOBBY

RECEPTION

ITALIAN CAFÉ LOUNGE

RESTAURANT MEZZANINE

HOTEL RESTAURANT

FUNCTION HALL

OTHER PERSPECTIVES

Beach Cottage Interior

MAIN ENTRANCE

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