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It gives us immense pleasure to announce the publication of the PEC journal (Volume 1, April 2024)

PEC journal publishes research-based articles and papers from the faculties and students of the college. The articles and papers are based on the field of science and engineering. We hope our readers will find there papers discourse knowledgeably. The journal is published once a year and each issue publishes original articles, review articles and different case reports.

We would like to express our heartfelt gratitude towards the authors, advisory board and patron for the immense support and constant motivation.
We would also like to cheer up the efforts of the designer and printing press in bringing out this journal in this form in a short period.

Editorial Board
April 2024

TABLE OF CONTENTS

STATE OF ART REVIEW ON ANALYTICAL APPROACHES FOR THE DESIGN OF THE WELDED CONNECTION

Abhishek Ghimire
Department of Steel and Timber Structure, Faculty of Civil Engineering, Czech Technical University in Prague
Email: abhi.ghimire45@gmail.com

Abstract: This paper presents an overview of analytical approaches for designing welded connections based on the existing design codes and standards of Eurocode, US standards, Canadian Standards, and New Zealand standards. Several independent research projects and design guidelines have demonstrated and allowed that the strength and ductility of fillet welds are a function of the direction of loading.

Keywords: Fillet welds, Filler metal, Base metal, Load bearing capacity, weld direction

1.0 Introduction

Welding is assembling two or more metallic parts by fusing them and filling them with molten metal from the electrode [1]. Structural integrity is one of the important aspects in many industrial sectors where welding is a primary technique for connection. Many steel industries are working to develop light and slender constructions of steel structures having good welding characteristics and high ductility [2]. Weld materials are the material added to the joint in its liquid state while connecting the base material during welding. There are two types of welding process, autogenous process (base metal participates in the formation of the joint by fusion or crystallization with the weld metal if present) and heterogeneous process (only the base material is the weld material used at a temperature lower than the melting temperature of the base material) [1]. It is necessary to ensure these welded connections' strength, ductility, and toughness to redistribute stresses and internal forces when steel is used [3].

There are several types of welded connection, fillet welds, fillet welds all around, butt welds, plug welds, and flare groove welds, used in the construction field based on their properties [4]. Fillet and partial penetration connections are commonly used in building constructions. Consequently, much experimental and analytical research considers the behaviour of fillet welds to predict the strength and ductility of these welds [5]. This paper summarized the analytical methods for the design of fillet welded connections with different design codes and standards.

2.0 Design Codes and Standards for Fillet Welded Connections

2.1 European Standards

The structural performance of the welded connection depends on the joint type and the corresponding load situation. According to Eurocode EN 1993-1-8 [4] and EN 1993-1-12 [6], fillet welded connection's design strength is calculated from the directional method and the mean stress method.

2.1.1 Directional Method:

For a more accurate directional method, the forces transmitted by the weld are resolved into stress components $\sigma_{\perp}$, $\tau_{\perp}$, and $\tau_{\parallel}$ within the area of the throat section because it is assumed to form the resisting and failing section [7]. Design resistance of the fillet welded connection is expressed in equation 1 as a function of the tensile strength of the base material along with the correlation factor β_w. However, the strength of the filler metal is not considered. According to EN 1993-1-8 [4], the normal stress parallel to the weld axis is not considered when verifying the design resistance of the weld. The

resolved stress components $\sigma_{\perp}$, $\tau_{\perp}$, and $\tau_{\parallel}$ which are shown in Figure 1 are calculated from design loads with the assumption of uniform stress distribution in the weld throat. The methodology is based on the description of an ultimate strength surface expressed by the Huber-Hencky-von-Mises criterion resulting in an equivalent stress $\sigma_{w,Ed}$ [7].

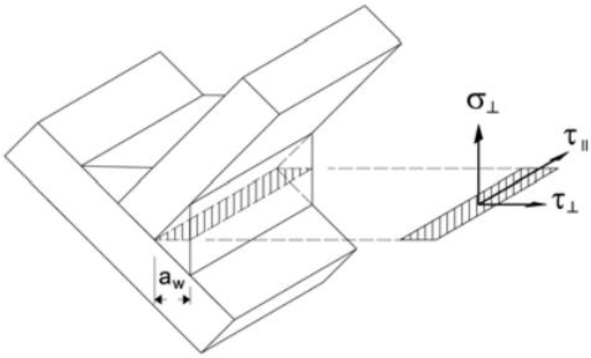


Figure 1: Stress Components longitudinal and perpendicular to the weld throat [3].

$$\sigma_{w,Ed} = \sqrt{\sigma_{\perp}^2 + 3.\tau_{\perp}^2 + 3.\tau_{\parallel}^2} \leq \frac{f_u}{\beta_w.\gamma_{M2}} \text{ and } \sigma_{\perp} \leq \frac{0.9.\ f_u}{\gamma_{M2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

Where,
f_u= Tensile strength of the base metal (Weaker part of the joined base metals)
γ_{M2}=1.25, Partial safety factor for the resistance of welds.
β_w= Correlation Factor depends on the grade of steel which is increased from 0.8 for mild steel to 1.0 for high strength steel see in Table 1 [4] and [6].

Table 1: Standard and steel grade with correlation factor.

Standard and steel grade			Correlation factor β_w
EN 10025	**EN 10210**	**EN 10219**	
S 235 S 235 W	S 235 H	S 235 H	0,8
S 275 S 275 N/NL S 275 M/ML	S 275 H S 275 NH/NLH	S 275 H S 275 NH/NLH S 275 MH/MLH	0,85
S 355 S 355 N/NL S 355 M/ML S 355 W	S 355 H S 355 NH/NLH	S 355 H S 355 NH/NLH S 355 MH/MLH	0,9
S 420 N/NL S 420 M/ML		S 420 MH/MLH	1,0
S 460 N/NL S 460 M/ML S 460 Q/QL/QL1	S 460 NH/NLH	S 460 NH/NLH S 460 MH/MLH	1,0

2.1.2 Simplified Method:

The mean stress method is a simplification of the directional method [3]. The design resistance of a fillet weld may be assumed to be adequate if, at every point along its length the resultant of all forces per unit length transmitted by the weld ($F_{w,Ed}$) satisfy the following criteria:

$F_{w,Ed} \leq F_{W,Rd}$

Where,

$F_{W,Ed}$ is the design value of the weld force per unit length;

$F_{W,Rd}$, is the design weld resistance per unit length.

Independent with the orientation of the weld throat plane to the applied force on it, the design weld resistance per unit weld should be determined from the equation 4.3 given in Eurocode 1993-1-8 [4]:

$F_{R,Ed} = f_{vw,d} * a$

Where:

$f_{vw,d}$, is the design shear strength of the weld.

$f_{vw,d} = \frac{f_u/\sqrt{3}}{\beta_w \gamma_{M2}}$

Where,

f_u , β_w , and γ_{M2} are defined in 2.1.1 [4].

a=Effective throat thickness of the fillet weld, which should be taken as the height of the largest triangle (with equal or unequal legs) that can be inscribed within the fusion faces and the weld surface, measured perpendicular to the outer side of this triangle and should not be less than 3 mm as per 4.5.2 (1) and (2) [4].

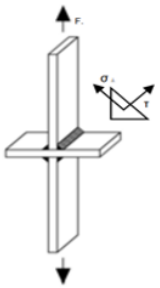
The design weld resistance for welds according to EN 1993-1-1 [8], EN 1993-1-8 [4] and EN 1993-1-12 [6] depending on the structural steel grades according to EN 10025-2 [9], EN 10025-3 [10], EN 10025-6 [11] in the case of fillet welds, $t \leq 40$ mm is summarized in Table 2. The table shows that the design resistance of the higher-strength steel grade S460 is somewhat lower than that of the steel grade S355.

Table 2: Values for the design weld resistance according to EN 1993 in case of fillet welds, t≤40 mm [3]

Steel grade		S235[1)]	S355[1)]	S460[2)]	S690[3)]
f_y	**[MPa]**	235	355	460	690
f_u	**[MPa]**	360	510	540	770
β_w	**[MPa]**	0.8	0.9	1.0	1.0
$f_u/(\beta_w \cdot \gamma_{M2})$	**[MPa]**	360	453	432	616

Example calculations for the weld perpendicular and parallel to the direction of a force applied and the design resistance of fillet welds according to European Standards are presented in Table 3 and Table 4, respectively [12].

Table 3: Design strength of welds perpendicular and parallel to the direction of action of force according to Eurocode [4]:

Sample	Description	Details
	Normal & Shear Stress perpendicular to the direction of force:	$\sigma_\perp = \tau_\perp = \frac{F}{\sqrt{2}A_w}$
	Directional Method	$\sqrt{\sigma_\perp^2 + 3\tau_\perp^2} \le \frac{f_{u,k}}{\beta_w \cdot \gamma_{M2}} \rightarrow \frac{F}{A_w} \le \frac{f_{u,k}}{\sqrt{2} \cdot \beta_w \cdot \gamma_{M2}}$
	Simplified Method	$\frac{F}{A_w} \le \frac{f_{u,k}}{\sqrt{3} \cdot \beta_w \cdot \gamma_{M2}}$
	Comparision	Directional Method gives 22% more durable results than that of simplified method.

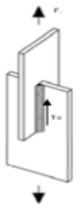
Sample	Description	Details
	Shear Stress parallel to the direction of force:	$\tau_{II} = \frac{F}{A_w}$
	Directional Method	$\sqrt{3 \cdot \tau_{II}^2} \le \frac{f_{u,k}}{\beta_w \cdot \gamma_{M2}} \rightarrow \frac{F}{A_w} \le \frac{f_{u,k}}{\sqrt{3} \cdot \beta_w \cdot \gamma_{M2}}$
	Simplified Method	$\frac{F}{A_w} \le \frac{f_{u,k}}{\sqrt{3} \cdot \beta_w \cdot \gamma_{M2}}$
	Comparision	Same Strength from both method

Table 4: Design resistance of fillet welds according to EN 1993-1-8 [4]

	Combination of base metal & filler metal	
	S690Q-G42	S690-G46
Base Metal(f_y) [N/mm2]	690	690
Base Metal(f_u) [N/mm2]	770	770
Filler Metal(f_y) [N/mm2]	420	460
Filler Metal(f_u) [N/mm2]	500	530
β_w	1	1
γ_{M2}	1.25	1.25
$f_{vw,d} = \frac{f_u/\sqrt{3}}{\beta_w \gamma_{M2}}$	230.94	244.80

2.2 US Standards

According to AISC 360-16 [13], there are two possible approaches for calculating the load-bearing capacity of welded connection; Load and Resistance Factor Design (LRFD) & Allowable Stress Design (AWD). In the following, only the LRFD method is considered;

Design Strength of weld metal:

$(\emptyset R_n) = \emptyset F_w A_{we}$ …….. (1)

Where, A_{we}= Effective area of the weld, in.2 (mm2) = weld throat thickness (0.707 * S) * weld leg length

Where, S= thickness of weld and F_w= Nominal stress of the weld metal, ksi (MPa). The value of Ø, Ω, and F_w and limitations thereon, are given in Table J2.5. Resistance Factor (Ø)= 0.75 (LRFD); Ω= 2.0 (ASD).

For the verification equation (1) (LRFD), there are two methods for determining the load-bearing capacity of welded joints. The first method only considers the strength of the filler metal from equation (2).

In the second procedure, equation (3), the carrying capacity of Welded joints depending on the strength of the filler metal F_{EXX} and the angle θ between the weld and force direction is determined. The load capacity is calculated with the following equations:

$F_w = 0.60.F_{EXX}$ ……. (2)

$F_w = 0.60.F_{EXX}\ (1.0 + 0.50 * Sin^{1.5}(\theta))$ ……. (3)

Where, F_{EXX}= Classification number, the minimum tensile strength of the filler metal.

θ = Angle between the longitudinal direction of the force and the weld.

The minimum tensile strength of the filler metal F_{EXX} is given in Table 5. The load-bearing capacity of the welded connection is calculated as a function of the filler metal and it is necessary to specify the steels belonging to the filler metals to be able to compare them with the other standards. The selection of the possible combinations of steel and welding consumables is given in Table 5.3 (AWS D1.1/D1.1M:2020) [14].

Table 5: Strength of steels with associated welding consumables according to AISC 360-16 [13](AWS D1.1/D1.1M:2020) [14].

Steel	f_y [N/mm2]	f_u[N/mm2]	F_{EXX}
A36 (≤20 mm)	250	400-550	60 ksi/70 ksi (414/483 N/mm2)
A913 (Size 50)	345	Min. 455	70 ksi (483 N/mm2)
A913 (Size 60)	415	Min. 520	80 ksi (552 N/mm2)
A913 (Size 65)	450	Min. 550	80 ksi (552 N/mm2)
A852	485	620-760	90 ksi (621 N/mm2)

Table 6: Design resistance of fillet welds according to AISC 360-16 [13], [AWS D1.1, 2020] [14]

	Welding Consumables material		
	60 ksi	70 ksi	80 ksi
f_y [ksi/ N/mm2]	48/331	57/393	67/462
f_u [ksi/ N/mm2]	60/414	70/483	80/552
F_{EXX}[N/mm2]	414	483	552
Ø [-]	0.75		
$Ø * 0.60 * F_{EXX}$	186.3	217.35	248.4
$Ø * 0.60 * F_{EXX}\ (1.0 + 0.50 * Sin^{1.5}(\theta))$			
$\theta = 0^{\circ}$ (welds parallel to the direction of force)	186.3	217.35	248.4
$\theta = 90^{\circ}$(welds perpendicular to the direction of force)	279.45	326.03	372.6

2.3 Canadian Standards

The verification method according to the Canadian standards is very similar to the method according to the US standards to determine the strength of the welded connection. There is only a difference for the resistance factor in the design equation (3) [12].

The Canadian standards used pre-factor of 0.67* $Ø_w$ while the US standards used 0.60* Ø. The design equations thus lead to comparable results. The determination of the load-bearing capacity of welded joints considers the strength of the filler metal and the angle between the longitudinal direction of the weld and the direction of a force. In the Canadian design regulation CAN / NSA S16.1-94 (2006), the load-bearing capacity is described using the following equation:

$F_w = 0.67 * Ø_w * A_w * X_u\ (1.0 + 0.50 * Sin^{1.5}(\theta))$ ……. (4)

Where, $Ø_w$= Resistance coefficient for welds= 0.67; A_w= Effective weld area

X_u= Classification number, the minimum tensile strength of the filler metal.

Table 7: Design resistance of fillet welds according to CAN/NSA S16.1-94 (2006)

	Welding Consumables material	
	E410/E60	E550/E80
$\boldsymbol{X_u}$=$\boldsymbol{f_u}$ [N/mm2]	410	550
$\boldsymbol{Ø_w}$	0.67	
$\boldsymbol{F_w = 0.67 * Ø_w * A_w * X_u\ (1.0 + 0.50 * Sin^{1.5}(\theta))}$		
$\boldsymbol{\theta = 0^\circ}$ (welds parallel to the direction of force)	184.05	246.90
$\boldsymbol{\theta = 90^\circ}$ (welds perpendicular to the direction of force)	276.07	370.34

2.3 New Zealand Standards

According to New Zealand Standards (Clause: 9.7.3.10, NZS 3404: Part 1:1997) [15], the ultimate limit state design capacity per unit length of fillet welds can be determined by following which should be the vectorial sum of the design forces per unit length on the effective area of the weld:

$V_w^* = Ø * V_w$

Where, $Ø =$ Strength reduction factor= 0.70 (See table 3.3) [15] and V_w= Nominal capacity of a fillet weld per unit length.

$V_w = 0.6 * f_{uw} * t_t * k_r$

Where,

f_{uw}= Nominal tensile strength of weld metal (see table 9.7.3.10 (1)) [15], expect that for welds within or connecting category 1 or 2 members (see 4.5, 12.3), $f_{uw} \geq f_u$ is required.

f_u= tensile strength of parent metal

t_t= Design throat thickness (Clause 9.7.3.4) [15]

k_r= Reduction factor given in table 9.7.3.10 (2) [15] to account for the length of a welded lap connection. For all other connection types, $k_r = 1.0$

Table 8: Design resistance of fillet welds according to NZS 3404: Part 1:1997 [15]

	Welding Consumables material	
	E41XX	E48XX
f_{uw} [N/mm2]	410	480
∅	0.70	
k_r	1	1
$V_w = 0.6 * f_{uw} * k_r$	246	288
$V_w^* = ∅ * V_w$ [N/mm2]	172.2	201.6

3 Summary

This paper summarizes various international design codes and standards for the analytical calculation of welded connections. It specifically examines the Eurocode, US standards, Canadian standards, and New Zealand standards to determine the design strength of fillet weld connections. Overall, the strength of a welded connection is significantly influenced by the filler material and the direction of the force applied to the weld. When the welds are perpendicular to the direction of the applied force, the strength of the welded connection increases—by 22% according to Eurocode and by up to 50% according to US and Canadian standards—compared to welds that are parallel to the direction of the force.

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SEISMIC ANALYSIS AND DESIGN OF PUBLIC BUILDING

Sudip Ranabhat, Sameer Tripathi, Savyata Acharya, Prabhat Regmi, Krishna Ghimire
Department of Civil Engineering, Pokhara Engineering College, Pokhara University
Corresponding email: krishnaghimire030@gmail.com

ABSTRACT

The seismic analysis and design of a public structure, the Ward Office Building, is presented in this paper. Because of the building's location in a seismically active area, it is crucial to guarantee its structural stability in the event of an earthquake. A finite element model of the building in SAP 2000 v 20 was used for the seismic analysis, which was carried out using NBC 105:2020 (Seismic Design of Building in Nepal). NBC 105:2020 permits to analyze the building in the states of Ultimate Limit State (ULS) and Serviceability Limit State (SLS). The building is analyzed using both Equivalent Static Method (ESM) and Modal Response Specttum Method (MRSM). Base Shear of the building is calculated by multiplying the Seismic Weight with the horizontal base shear coefficient calculated using NBC 105:2020. The Base Shear calculated in ULS is found to be 4% greater than in SLS. The building's seismic analysis is completed in terms of eccentricity, torsion, drift, and displacement, and the findings demonstrated that the structure could withstand the design earthquake without collapsing. The building's design includes several seismic-resistant elements, including shear walls and moment-resisting frames. This features help to distribute the seismic forces throughout the building and prevent it from collapsing. The paper also discusses the challenges faced during the seismic analysis and design of the Ward Office Building. These challenges included the complexity of the building's geometry and the need to consider a variety of seismic loading conditions. The paper concludes by summarizing the key findings of the study and outlining the implications for future seismic design projects.

KEY WORDS: Base Shear, Displacement, Drift, Eccentricity, Torsion, Earthquake.

1. INTRODUCTION

1.1. BACKGROUND

In seismically active areas, earthquakes are the main threat to the development of civil infrastructure. Since it is located in the subduction zone of the Indo-Australian and Eurasian tectonic plates, our nation, Nepal, is in a seismically unstable area. Such an area is prone in weak to moderate ground shaking [1].

In 1988, an earthquake hit the Nepal-India border. A 6.8 on the Richter scale of earthquake occurred, the earthquake caused more than 722 deaths in Nepal and nearly 78,000 dwelling places were destroyed beyond repair in India and Nepal. By considering this fact, NBC 105:1994 came into practie, which was prepared by subcontractor's team working within the Department of Building, the team including members of the Department and the MHPP [2]. This practice analyzes the building in Ultimate Limit State [3], meaning that safety of the building against its structural collapse, safety against failure of elements which could be life threatening and safety against failure of critical functions which are critical to safe evacuation of people from the building is ensured [4].

The magnitude-7.8 earthquake on April 25, 2015 and its aftershocks, including the magnitude-7.3 aftershock on May 12, 2015, caused massive damage to the built environment in Nepal. Near the epicenter, the main event had a maximum Mercalli Intensity (MMI) of

IX, caused over 9000 fatalities, and resulted in more than 20000 injuries. The cost associated with the earthquake was estimated $5 US Billion or nearly a quarter of Nepal's GDP. This event is considered the worst natural disaster in Nepal in the past eighty years [5]. This event realized that the existing code of practice was not effective and as a result, NBC 105:2020 came into practice. This code of practice analyzes the building in both Ultimate Limit State (ULS) and Serviceability Limit State (SLS), ensuring the safety of structure and users, and serviceability of the structural members even after seismic action [4].

Major Civil Infrastructures like buildings are vulnerable to earthquake damage. Based on the recent scenario in earthquake studies, it is summarized that not only non-engineered but the earthquake also affect the engineered structures [6]. Buildings are being constructed closer to property lines, which may cause pounding during earthquakes due to the rapid population growth, higher land costs, and unplanned urbanization.

Structures designed only for vertical shaking, in general, may not be able to safely sustain the effect of horizontal shaking. Hence, it is necessary to ensure that the structure is adequately resistant to horizontal earthquake shaking too[7]. Seismic Analysis is carried out in order to predict the behavior of RCC Building during the seismic action (Earthquake).

1.2. SALIENT FEATURES OF BUILDING

Table 1: Features of the building [4,/8]

Type of Building	Office Building
Location	Pokhara-01, Simpani
Plinth Area	284.81 m^2
Ground Coverage	29.04 % < 50 % (ok)
Floor Area Ratio	2
Soil Type	Medium Type
Seismic Zone	Zone V

1.3. BUILDING DETAILS

Table 2: Building Details [4/8/9]

Category of Building	Mid-Rise Building
Number of Storey	5 (G + 3 + Staircase Cover)
Floor Height	3.2 m
Size of Building	Length = 12400 mm, Breadth = 25400 mm
Grade of Concrete	M25 for Beam, Column and Slab
Grade of Steel	Fe 500
Type of Slab	Two - way Slab
Type of Foundation	Isolated Footing
Type of Stair-case	3rd Quarter Landing Type
Structural System	Special RC Moment Resisting Frame Structure (SMRF)
Beam Size	Main Beam: 350mm*550mm Secondary Beam: 225mm*400mm
Column Size	500mm*500mm
Slab Thickness	150mm
Shear Wall Thickness	200mm

1.4. ARCHITECTURAL DRAWING

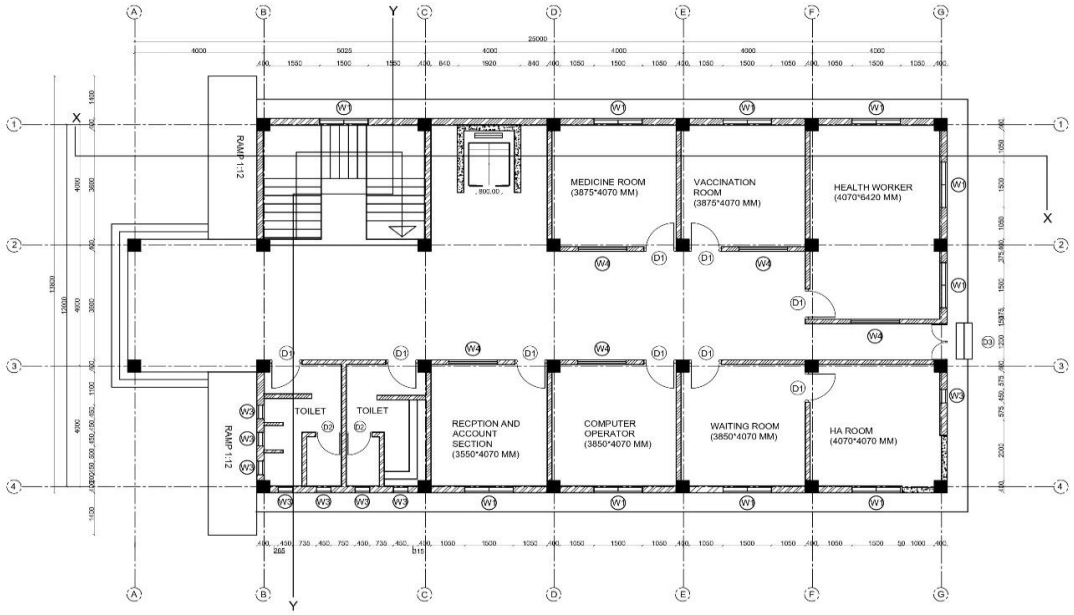


Figure 1: Architectural Drawing of Ground Floor

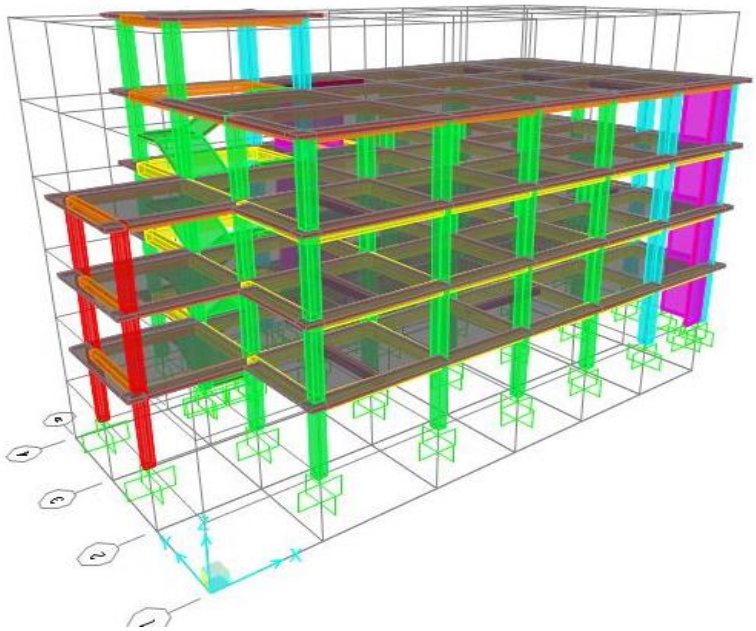


Figure 2: 3-D Drawing (from SAP)

1.5. METHODOLOGY

The methodologies for seismic hazard analyses, selection of earthquake records for design, and acceptance criteria, however, are widely different between the countries [10]. It is preferable to verify the model and the analysis parameters first using the ESM and then only go through the MRSM.

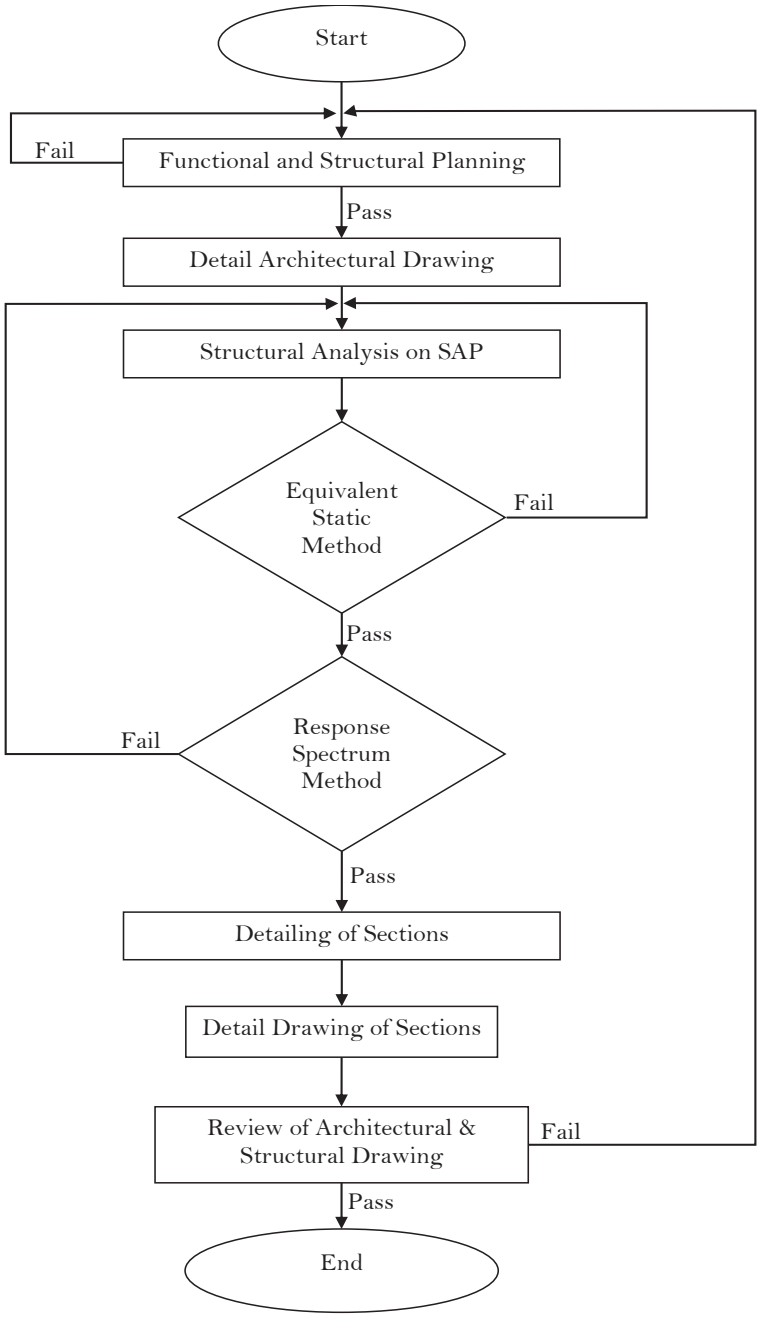


Figure 3: Methodological Flowchart

2. SEISMIC ANALYSIS

2.1. MODELING AND DEFINITION

Modeling is done using SAP 2000 v 20, using finite element model of building. Modeling is done as per the architectural drawing and the changes are made later as per the structural requirements. Initially, building was analyzed without considering the shear wall (indicated by colour: Pink, Grid: F4-G4 and G3-G4). This encountered torsion in the building and again shear wall (indicated by colour: Pink, Grid: F4-G4 and G3-G4) was considered. All the analysis, result and discussion are made on the later case. Special attention shall be given while modelling the building in SAP as a very small and unnecessary section may cause the failure of the whole structure which is undesirable.

2.1.1. Material Definition

Material is defined as per the **clause 2.1 of NBC 105:2020.**

Table 3: Material Used

Concrete	M25
Steel/Rebar	Fe500

2.1.2. Section Definition

Column and Beam are defined as frame section whereas Slab and Shear wall are defined as area section in SAP 2000. Section is defined as per the preliminary design which are as;

Table 4: Preliminary Design Data

Column	400 mm × 400 mm
Main Beam	300 mm × 500 mm
Secondary Beam	250 mm × 400 mm
Slab	150 mm
Shear wall	200 mm

2.2. LOAD ASSIGN

Dead load is taken from **IS 875 part I** and live load are taken from **IS 875 part II**. The assigned dead load and live load are shown in the table as:

Table 5: Dead Load [11]

PARAMETERS	DEAD LOAD	PARAMETERS	DEAD LOAD
One brick thick External wall Without Opening	13.46 KN/m	Dead load of Floor finish for Roof	1.3924 KN/m²
One brick thick External wall 25% Opening	10.10 KN/m	Dead load of Floor finish without Marble	1.513 KN/m²
Half brick thick External wall Without Opening	8.95 KN/m	Dead load of Floor finish with Marble	1.71 KN/m²
Half brick thick External wall With Opening	6.72 KN/m	Dead load of Floor finish with Tile	1.185 KN/m²
One brick, 1.2 m high parapet wall	6.18 KN/m		

Table 6: Live Load [12]

PARAMETERS	LIVE LOAD
Balcony, staircase, lobby, office room without separate storage	4 KN/m²
Kitchen, conference hall	3 KN/m²
Office room with separate storage	2.5 KN/m²
Toilet, bathroom	2 KN/m²
Roof accessible	1.5 KN/m²
Roof not accessible	0.75 KN/m²

2.3. LOAD COMBINATION

The load combination is taken according to **clause 3.6.1 of NBC 105: 2020 [4].**

Table 7: Load Combination

S.N.	Combination	S.N.	Combination
1	DL + LL	7	DL + 0.3 LL + RS_x
2	1.2 DL + 1.5 LL	8	DL + 0.3 LL – RS_x
3	DL + 0.3 LL + EQ_x	9	DL + 0.3 LL + RS_y
4	DL + 0.3 LL – EQ_x	10	DL + 0.3 LL – RS_y
5	DL + 0.3 LL + EQ_y	11	DL + 0.5 LL
6	DL + 0.3 LL – EQ_y		

2.4. METHOD OF ANALYSIS

Clause 3.1 of NBC 105: 2020 provides various method for the analysis [4]. The building was first analyzed using the Equivalent Static Method and then using Response Spectrum Method satisfying the condition of **clause 3.2.2.**

Horizontal Base Shear Coefficient was calculated using **clause 7.2 of NBC 105: 2020** to be used for the Equivalent Static Method. The Response Spectrum function was defined in the function section of SAP 2000 from the user defined data, using **clause 4.1.2 and equation 4.1(2) of NBC 105:2020**. The function displays in the form of curve as:

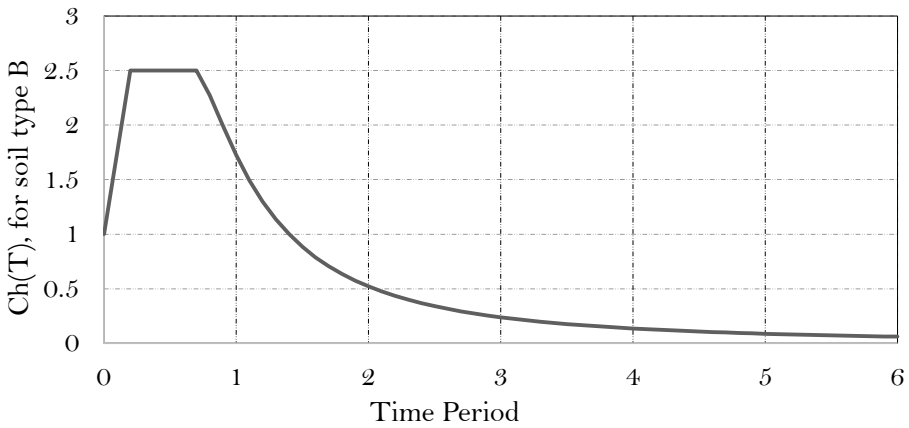


Figure 4: Response Spectrum Curve

2.5. CALCULATION OF BASE SHEAR(V_B)

The base shear is calculated using **clause 7.2 of NBC 105: 2020** for both Ultimate Limit State (ULS) and Serviceability Limit State (SLS), which is equal to the product of horizontal base shear coefficient and the seismic weight [4].

2.5.1. Calculation of horizontal base shear coefficient (C_dT_i):

It is calculated as per **clause 7.1 of NBC 105: 2020.**

Table 8: Horizontal Base Shear Coefficient Calculation [4]

ULS

Description of parameter	Notation	Calculation	Reference
Horizontal Base Shear	V_B	$C_d(T_1) \times W$	Cl. 5.2
Horizontal Base Shear Coefficient	Cd(T1)	$\frac{C(T_1)}{R_u \times \Omega_u}$	Cl. 6.1.1
Elastic Site Spectra	R_u	4	Cl. 5.3
Over Strength Factor for ULS	Ω_u	1.5	Cl.5.4
Elastic Site Spectra	$C(T_1)$	Ch(T)ZI	Cl. 4.1.1
Zone Factor	Z	0.3	Cl. 4.1.4
Importance Factor	I	1.25	Cl. 4.1.5
Time Period of Vibration	T	$K \times t \times H^{3/4}$	Cl. 5.1
	kt	0.075	
H = Height of the building from foundation or from top of a rigid basement			
	H	16	
	T	0.6	Cl. 4.1.2
Multiply by 1.25	T	0.75	
Assume that the soil of Pokhara is of medium type. (Soil B type)			
Lower Value of Flat Part of Spectrum	T_a	0	Table 4.1
Upper Value of Flat Part of Spectrum	T_c	0.7	
Peak spectral acceleration	a	2.5	
Factor That Controls Descending Branch of Spectrum	K	1.8	
Here, T >Tc. So ChT= $a \times [k+(1-K)\left(\frac{T_c}{2}\right)^2] \times \left(\frac{T_c}{T}\right)^2$			
Spectral Shape Factor	Ch(T)	2.402330864	Cl. 4.1.2
	$C(T_1)$	0.900874074	
Horizontal Base Shear Coefficient	$Cd(T_1)$	0.150145679	

SLS

Description of parameter	Notation	Calculation	Reference
Horizontal Base Shear	V_B	$C_d(T_1) \times W$	Cl. 5.2
Horizontal Base Shear Coefficient	$Cd(T_1)$	$\frac{Cs(T_1)}{\Omega_s}$	Cl. 6.1.2
Over Strength Factor for SLS	Ω_s	1.25	Cl.5.4
Elastic Site Spectra	$C_s(T_1)$	0.20 C(T)	Cl. 4.2
	C(T)	Ch(T)ZI	
Zone Factor	Z	0.3	Cl. 4.1.4
Importance Factor	I	1.25	Cl. 4.1.5
Time Period of Vibration	T	$K \times t \times H^{3/4}$	Cl. 5.1
	kt	0.075	
H = Height of the building from foundation or from top of a rigid basement			
	H	16	
	T	0.6	Cl. 4.1.2
Multiply by 1.25	T	0.75	
Assume that the soil of Pokhara is of medium type. (Soil B type)			
Lower Value of Flat Part of Spectrum	Ta	0	Table 4.1
Upper Value of Flat Part of Spectrum	Tc	0.7	
Peak Spectral Acceleration	a	2.5	
Factor That Controls Descending Branch of Spectrum	K	1.8	
Here, T>Tc. So ChT= $a \times [k+(1-K)\left(\frac{T_c}{2}\right)^2] \times \left(\frac{T_c}{T}\right)^2$			
Spectral Shape Factor	Ch(T)	2.40233086	Cl. 4.1.2
	$C(T_1)$	0.90087407	
	Cs(T1)	0.18017481	
Horizontal Base Shear Coefficient	Cd(T1)	0.1441	

From the above table, the calculated horizontal base shear coefficient is:

ULS= 0.1501

SLS= 0.1441

2.5.2. Calculation of Seismic Weight (W_i)

It is calculated as per **clause 5.2 of NBC 105: 2020,** which is equal to the sum of dead load plus some percentage of live load. Percentage of live load to be taken is given in **table 5.1. of NBC 105:2020 [4].**

Calculated W_i = 15469.881 KN

Table 9: Base Shear Calculation Summary Table

Method	Seismic Weight (KN)	Cd(T1)	Base Shear (KN)
ULS	15469.881	0.1501	2322.029
SLS	15469.881	0.1441	2229.209

2.6. TERMS OF ANALYSIS

2.6.1. Eccentricity

Eccentricity is generally defined as the differences between center of mass and center of stiffness. The center of mass is the point where the entire mass of an object is concentrated. The center of rigidity is the point where the entire stiffness of an object is concentrated. Eccentricity arises when the center of mass doesn't coincide with the center of stiffness.Center of mass is contributed by all the RCC structures of the system including all horizontal and lateral load resisting system. However, only horizontal load resisting system like Column and Shear wall are considered to provide the stiffness in the system and act as lateral load resisting system. For the analysis for torsional effects, the applied torsion at each level shall use either the forces calculated by the Equivalent Static Method or the combined story inertial forces found in a Modal Response Spectrum Method. As per the **clause 5.7 of NBC 105:2020**, the accidental eccentricity can be taken as ±0.1b [4]. For example, if 23.5 m is the dimension of the building in any direction (say X), then the allowable eccentricity is ±2.35 m.

2.6.2. Torsion

Torsion in general sense is the twisting or rotation effect, produced by the forces that cause the unequal movement of floor with in the same level. The major source of torsion is eccentricity and the initial attempts shall be made to minimize the eccentricity in the building. Eccentricity in the building can be minimize by:

i. Maintaining symmetry in buildings,
ii. Avoiding change in direction of forces within a frame,
iii. Not allowing to intersect the cantilever section, and
iv. Designing the structural members to withstand torsional forces/moments as per standard codes.

Clause 5.5.2.1 of NBC 105: 2020. gives the criteria to check whether the building is safe in torsion or not. As per code, the maximum horizontal displacement (Umax) of any floor in the direction of the lateral force (applied at the center of mass) at one end of the story is more

than 1.5 times its minimum horizontal displacement (Umin) at the far end of the same story in that direction [4]. If Umax/Umin≥1.5, then the building is subjected to torsion.

2.6.3. Inter Storey Drift

It is the relative displacement of one floor with respect to the other floor. Determination of the drift is essential in predicting the diaphragm as flexible, semi-rigid or rigid, that is important during defining constraints in SAP. As per **clause 5.6.3 of NBC 105: 2020**, the ratio of the inter-story deflection to the corresponding story height shall not exceed 2.5% at Ultimate Limit State and 0.6% at Serviceability Limit State [4].

2.6.4. Deflection

It is the displacement of any floor with respect to the ground, as displacement in ground is generally assumed to be zero in both x and y direction. As per **clause 5.6 of NBC 105: 2020**, the displacement at the top story shall not exceed $0.025 \times \frac{H}{R_u}$ at Ultimate Limit State and 0.006*H at Serviceability Limit State [4]. For example, if the height of the building is 20m, then the deflection of building shall not exceed 125mm in ULS and 120mm in SLS.

3. RESULT AND DISCUSSION

The interpretation of the analysis terms were done after completing the analysis of building in both ESM and MRSM. Distribution of the lateral forces at each foor, eccentricity ratio, base shear, torsion, displacement, inter-storey drift were some of the observed parameters. The used version of software did not have the inbuilt function to analyze the parameters in the form of diagram, graphs, etc. and hence all the parameters of analysis along X and Y-direction are compared in both Ultimate Limit State and Serviceability Limit State, in the form of table, graphs, etc. manually by using spreadsheet model.

Table 10: Eccentricity Check

Floor	GL	1F	2F	3F
X_m	14.4	14.15	14.11	13.9
Y_m	6.382	6.11	6.081	6.14
X_{cr}	13.89	13.89	13.89	14.47
Y_{cr}	6.21	6.21	6.21	6.212
$X_m - X_{cr}$	0.512	0.258	0.215	-0.572
$Y_{cr} - Y_m$	-0.172	0.1	0.129	0.072
$0.1 \times L_y$	1.24	1.24	1.24	1.24
$0.1 \times L_x$	2.54	2.54	2.54	2.54
Result	OK	OK	OK	OK

The allowable value of eccentricity as per **clause 5.7 of NBC 105:2020** is 2.54m in X-direction and 1.24m in Y-direction. Xm,Ym represents centre of mass and Xcr,Ycr represents centre of rigidity in X and Y-direction respeectively. As the used version of software (SAP 2000 V20) donot have the inbuilt function to determine the centre of mass and centre of

rigidity, manual calculation is done This table shows that the calculated values are less than the allowed value. This primiraliy indicates that building is less affected by torsion. However, the following torsion check confirms the presence of torsion in the building.

As torsion is the effect produced due to presence of eccentricity, no any structures can be free from torsion, but its value can be limited within certain value. NBC 105:2020 prescribes the maximum ratio to be 1.5 for a building less affected by torsion. The figure 5 shown below shows that the torsional ratio is within the limit. The maximum torsion is demonstrated by SLS in Y-direction.

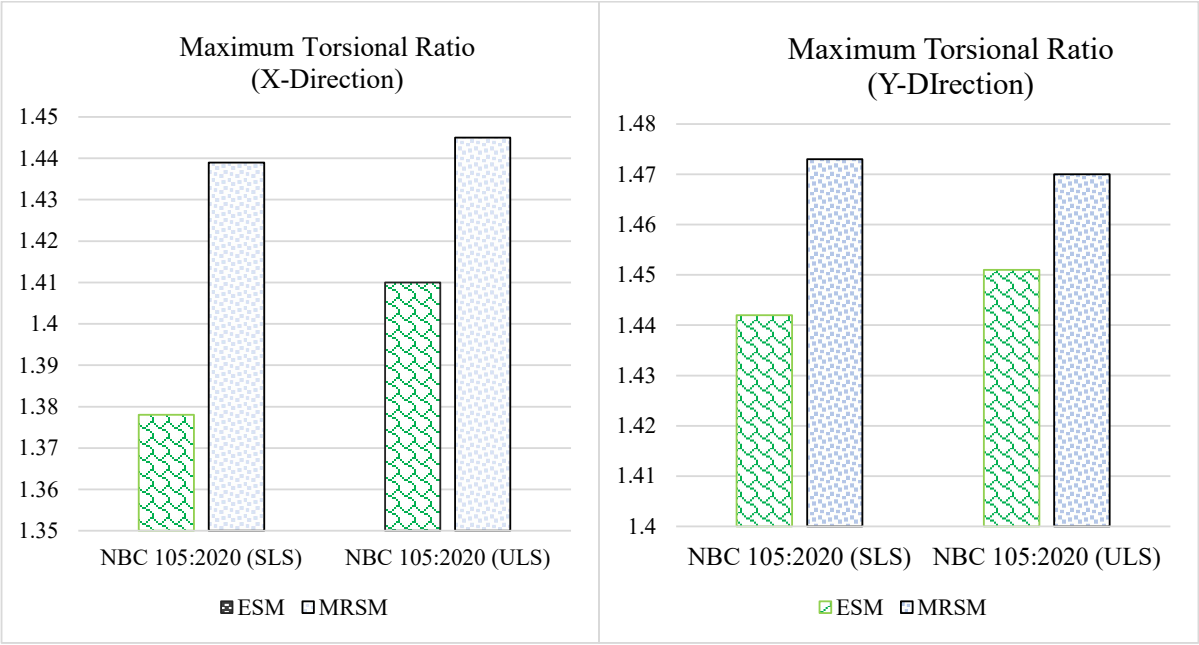
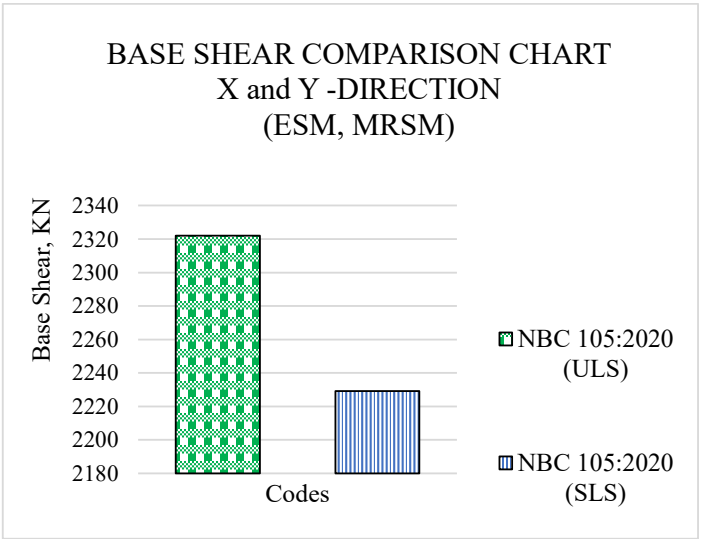


Figure 5: Base Shear Comparision Chart



Base Shear	
Code	Value
NBC 105:2020 (ULS)	2322.03
NBC 105:2020 (SLS)	2229.21

Figure 6: Base Shear Comparision Chart

Unlinke the IS Codes, which gives the critera for different values of horizontal base shear coefficient in X and Y direction, NBC 105:2020 does not have any criteria to calculate the base shear in both direction. Hence, the value of Base Shear is same for both directions. However, Base Shear can be calculated for Ultimate Limit State and Serviceability Limit State using NBC 105:2020, which is equal to 2322.03 KN and 2229.21 KN respectively. The above graph displays a higher value of Base Shear for ULS than SLS, which is 4.12% higher. Sapkota A. et al. [13], Banjara R. et al.[16], Malla S. et al [17] also displayed a higher value of base shear for ULS [13].

Since, a scale factor which is the ratio of base shear obtained from ESM to MRSM, is used to calibrate the Base Shear value obtained during the analysis by MRSM, the base shear obtained by both the methods is same.

The figure 7 illustrates the distribution of lateral forces at each floor. The third floor experiences the greatest lateral force. The seismic weight and height of each floor determine how much lateral force is applied at each level. Although the basic method for allocating lateral forces along the height and in plan is similar in both methods, NBC 105:2020 (ULS) frequently produces higher forces than SLS due to variations in seismic coefficients, response reduction factor, and overstrength factor.

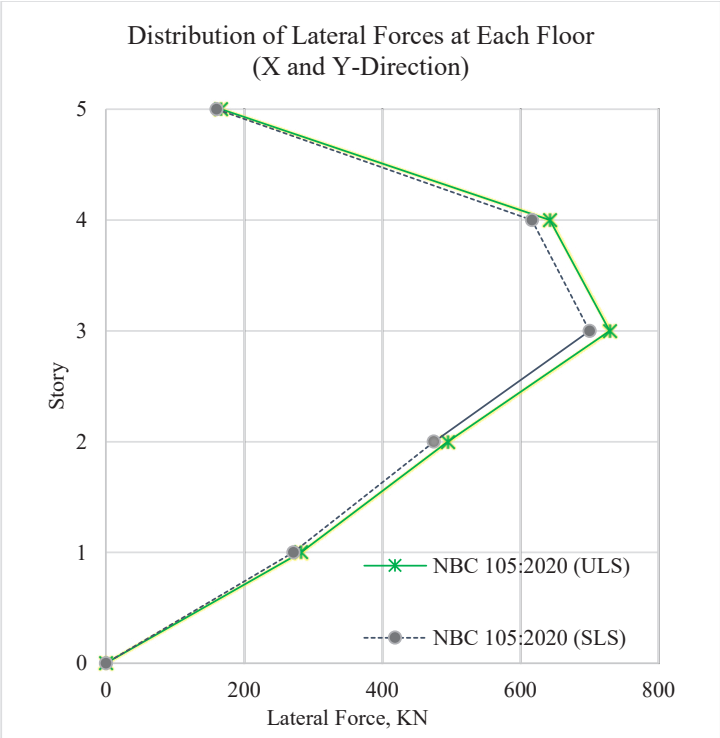


Figure 7: Distribution of Lateral Forces at Each Floor

The graph shown in the figure 8 displays the Displacement Comparision Chart. This chart shows that maximum displacement criteria as per **clause 5.6 of NBC 105: 2020** is with in the permissible value. The permissible value is 100mm in ULS and 96mm in SLS. The obtained maximum values (at the top of roof level) are 27.43mm and 33.04mm in ULS and SLS respectively both in Y-direction. For the considered model where centre of stiffness in X-direction is grater than in Y-direction (Table 10), the value of displacement is higher in Y-direction because of the fact that displacement is inversly proportional to stiffness of the structural system [14].

As compared to ESM, MRSM gave the higher value of displacement in both X and Y direction. Also as compared to the ULS, SLS gave the smaller value of displacement in both the directions.

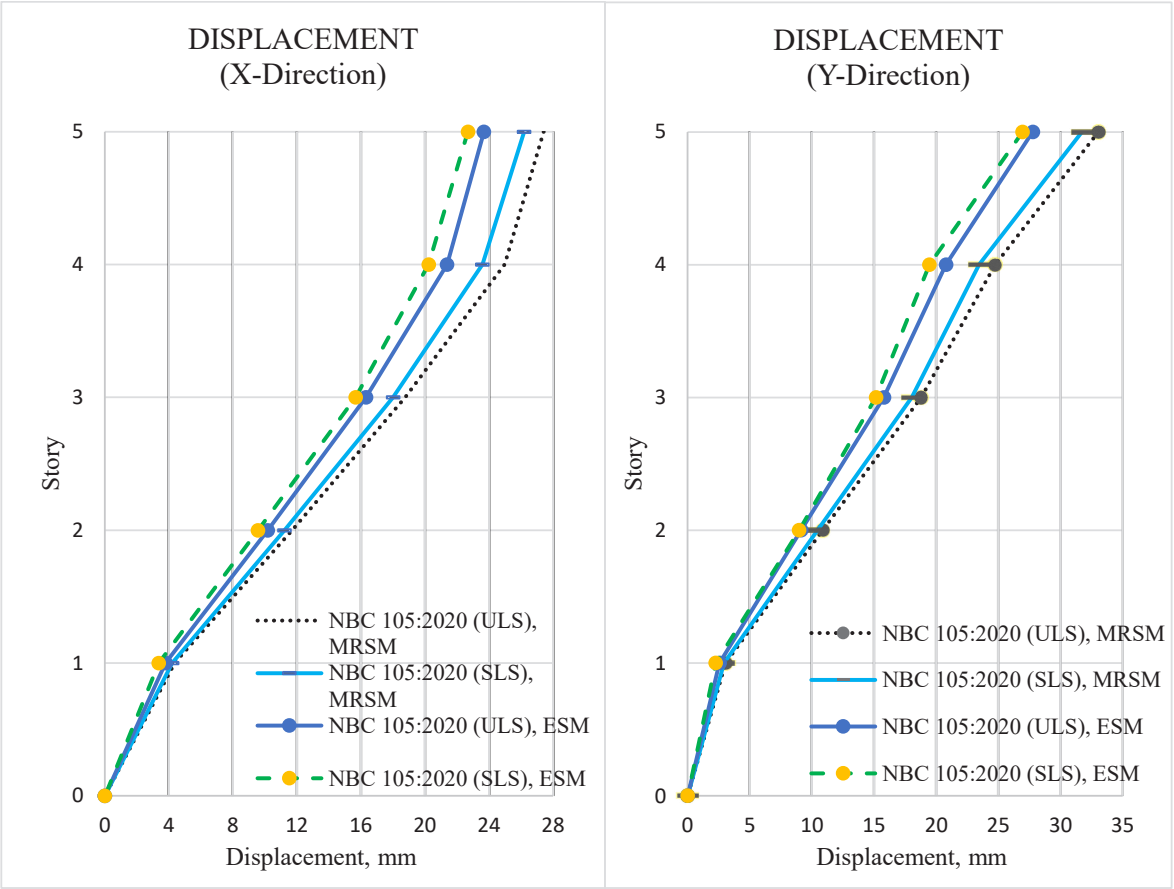


Figure 8: Displacement Comparision Chart

A higher value of Inter-story drift (ISD) ratio can be seen in the graph displayed in figure 9 in the Y-direction than in the X-direction. This is because of the direct relation between drift and displacement as ISD is the ratio of displacement between two adjacent floors. However, the values obtained are within the limit as prescribed by **clause 5.6.3 of NBC 105: 2020.**

Also from the graph, we can observe that the curves produced by MRSM seems to be more irregular than the curves produced by ESM. This is because, ESM makes the analysis considering only 1 mode, where as MRSM considers multiple modes for the analysis. This multiple consideration of modes makes the drift to be more dynamic [15].

The maximum drift ratio can be observed in the 2nd floor in X-direction, whereas the maximum value for Y-direction can be observed in 3rd floor, both by ULS analyzed by using MRSM. Also the graph displays that the ratio increases to a certain height, attains maximum value and then starts decreasing. The same nature of graph is displayed by Sapkota A. et al in their paper [13].

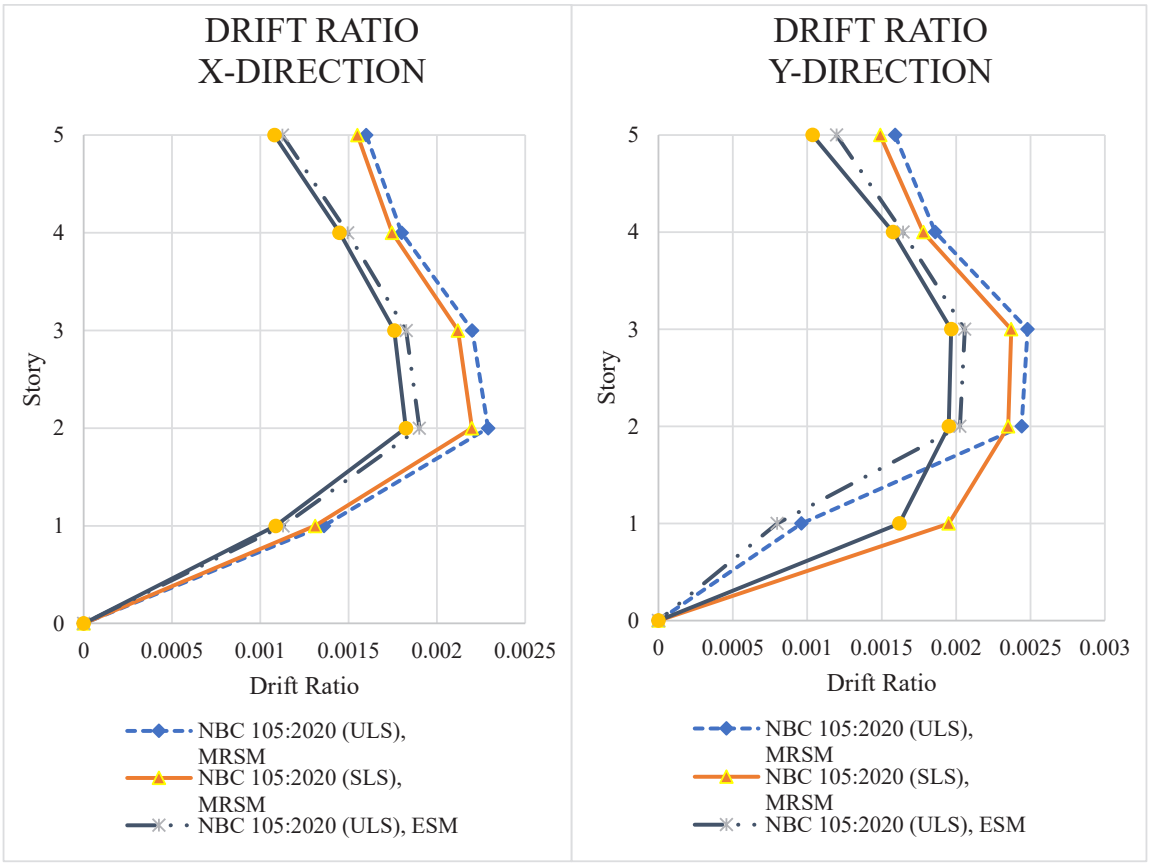


Figure 9: Inter-story Drift Comparision Chart

4. CONCLUSION

1. The building was analysed using both Equivalent Static Method (ESM) and Modal Response Specturum Method (MRSM) and all the requirements as specified by NBC 105:2000 were fulfilled, which ensured building to be seismically safe.
2. Base Shear calculated considering ULS is 2322.03 KN, which is 4% higher than the value calculated by SLS (2229.21 KN).

3. The main reason for the rise of torsion was presence of eccentricity and the change of stiffness at different level, due to the presence of shear wall around lift (fig 1). The effect of this shear wall on builidng was counteracted and value was limited within the code specified value by introducing the another shear wall at the bottom right corner(fig 1). The value of eccentricity and maximum torsional ratio obtained after the introduction of shear wall on the bottom right corner are in table 10 and figure 6 respectively.
4. The maximum value of drift ratio is found in Y-direction and was found to be 0.00248 (ULS, MRSM), followed by 0.00237 (SLS, MRSM), 0.002058 (ULS, ESM) and 0.001967 (SLS, ESM) in third floor and which is less than 0.025 (ULS) and 0.00625 (SLS) respectively. MRSM, ULS gave 17% higher value than ESM, ULS and MRSM, ULS gave 4.4% higher value than MRSM, SLS.
5. The maximum value of displacement was observed in Y-direction and calculated as 33.05 mm (ULS, MRSM), followed by 31.72 mm (SLS, MRSM), 27.272 mm (ULS, ESM) and 26.9448 mm (SLS, ESM) at top floor, which is less than 125mm (ULS) and 120 mm (SLS) respectively. MRSM, ULS gave 16% higher value than ESM, ULS and MRSM, ULS gave 4.02% higher value than MRSM, SLS.

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SEISMIC ANALYSIS OF A STEEL COMMERCIAL BUILDING

Sagar Subedi , Sajan Gurung, Sandip Gurung, Sunil Gurung, Bimal Bhandari
Department of Civil Engineering, Pokhara Engineering College, Pokhara University
Corresponding email: sagarsubedi612@gmail.com

Abstract

With change in the construction materials and change in the way of construction, steel structure has been broadly started to construct. What can be the ways of designing the seismic resistant multistoried commercial steel buildings following the Nepal Building Code and American Institute of Steel Construction (AISC). The building was designed using the building specifications and building by laws. The seismic activities play a vital role in the construction of steel building in Seismic zones rather than wind loads. The building was designed and checked for structure stability using ETABS. The connections are manually designed with considering AISC codes. The bolts used are high strength bolts. Results showed that the design of steel commercial building can be made following the seismic coefficients. The drifts and displacement occurring in the building can be counter balanced using the bracing connections. The result also showed the total building construction cost was less as compared to the same building if constructed using the RCC structure. The results are analyzed in terms of fundamental time period, storey shear, storey displacement, drift and overturning moment. The results indicate that all factors were within the permissible values.

Keywords: Steel Structure, AISC, storey drift, displacement, bracing

1. Introduction

The commercial building sector in Nepal shows diverse architectural styles, ranging from traditional designs influenced by Nepalese culture to modern and contemporary structures. Many commercial buildings incorporate elements of sustainability and energy efficiency, aiming to reduce environmental impact and operational costs. The construction of commercial buildings in Nepal is often influenced by various factors such as land availability, zoning regulations, building codes, seismic analysis and market demand. With the development in the technologies as well as availability of the skilled employees and designers, the steel structure construction has been seen to attract the attention of the public. Steel structures construction has gained significant traction in Nepal over the years due to its numerous advantages, including durability, cost-effectiveness, flexibility, and speed of construction. While Nepal is primarily known for its rich cultural heritage and historical buildings, the demand for modern infrastructure and urban development has led to an increased adoption of steel structures in the construction industry. In Nepal, the government has also recognized the benefits of steel structures and has incorporated them into various development plans and policies. The National Building Code of Nepal includes provisions and guidelines for the design and construction of steel structures, ensuring compliance with safety standards and promoting sustainable construction practices.

Overall, the increasing acceptance and implementation of steel structures construction in Nepal can be attributed to its seismic resistance, design flexibility, sustainability, and cost-effectiveness. As the country continues to experience urbanization and infrastructure development, steel structures are expected to play a vital role in shaping Nepal's modern built environment.

The project has been completed considering various codes of standard along with the building bylaws. With the completion in this project, it will be easier to relate the ease of construction of the steel structure in Seismic Zones. The analysis of the building is made with ETABS V20. The steel design will be made according to IS 800:2007. The concrete design will be made according to IS 456:2000 and SP 16. For ductile retaining IS 13920:2016 will be used. The connections shall be designed using AISC Seismic manuals. The deck design shall be done according to the Euro Codes.

2. Methodology

The building is completely analyzed following the below listed steps.

2.1. Planning phase

-The building was planned before the analysis for its functional purpose and structural ways. The functional planning included the allocation of spaces and check for the economic as well as environmental factors. The structural planning included determining the occupancy category, importance factor and seismic zone.

2.2. Load Assessment

- After the completion of the architectural drawing, the detailed load calculation of the building is made.

2.3. Modeling and Analysis

- The analysis was made using ETABS (Extended 3D Analysis of Building Systems) is a widely used software program for structural analysis and design of buildings. Creation and modification of the model, execution of the analysis, and checking and optimization of the design are all done through this single interface. Graphical displays of the results, including real-time display of time-history displacements are easily produced. The finite element library consists of different elements out of which the three-dimensional frame element was used in this analysis.

2.4. Check

- The result after analysis is analyzed. The building is checked for various factors such as storey drift, calculation of seismic loads, check for the displacement and check for the torsions and balance if any present and make the structure stable.

2.5. Result

- A final model which has no drifts and displacement in it and is safe in all the factors are finalized. The connections required are manually designed which can resist the seismic force.

Below shows the methodology chart.

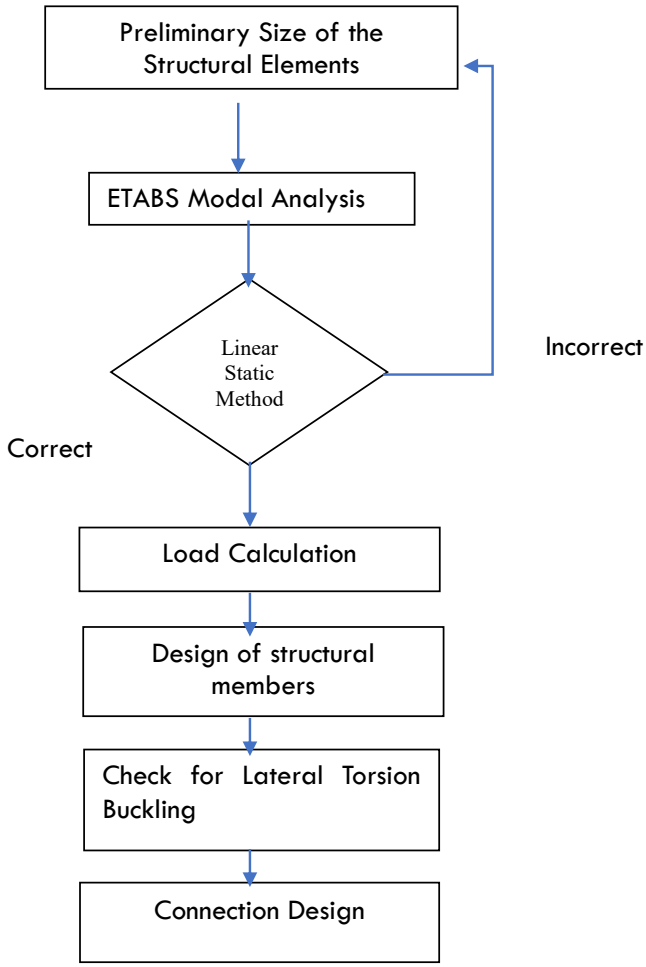


Figure 1: Methodological Flow Chart

3. Calculations and results

The calculations included the following topics:

3.1. Composite Beam

A composite beam refers to a structural element composed of two or more different materials working together to resist loads and support the structure. It typically consists of a steel section and a concrete slab connected together to form a single unit that acts as a beam. The steel section provides the tensile strength and stiffness, while the concrete slab contributes to the compression resistance and provides additional stiffness. The connection between the steel and concrete components in a composite beam is typically achieved through shear

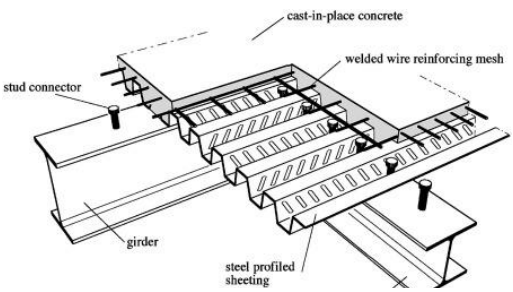


Figure 1: Composite Beam

connectors. These connectors, such as headed studs or welded studs, transfer shear forces between the steel and concrete, allowing them to act together as a single unit.

Check for Deflection

The beam is checked for:

- Deflection due to Dead Load
- Deflection due to Live Load

The deflection is less than the permissible deflection so the beam is safe.

Figure 2: Composite Beam Properties From ETABS

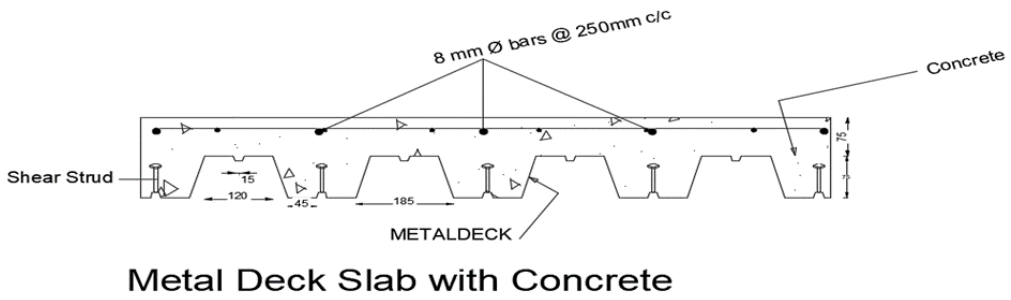


Figure 3: Composite Slab

3.2. Beam Column

A beam-column is a structural member that is subjected to axial compression and transverse bending at the same time. The combined compression and bending may be produced by an eccentrically applied axial load. The steel column in designed for beam column.

Section properties: 2 ISMC 400

Taking 2ISMC 400 as a trial section. Its properties are:

A=	12470	mm2	h=	400	mm
bf=	100	mm	tf=	15.3	mm
tw=	10	mm	ry=	114.93	mm
rz=	154.80	mm	Zez=	1494.00	cm3
Zey=	1198.00	cm3	Zpz=	1763.90	cm3
Zpy=	1381.80	cm3	Iy=	16472.40	cm4
Iz=	29880	cm4			

For built-up member, buckling class is 'c'.

Check for buckling: (Clause 9.3.1.1)

$$\frac{P}{P_{dy}} + K_y\frac{C_{my}M_y}{Md_y} + K_{LT}\frac{M_z}{Md_z} \le 1$$

$$\frac{P}{P_{dz}} + 0.6K_y\frac{C_{my}M_y}{Md_y} + K_z\frac{C_{mz}M_z}{Md_z} \le 1$$

Where,

$K_y = 1+(\lambda_y-0.2)n_y \le 1+0.8n_y$

$K_z = 1+(\lambda_z-0.2)n_z \le 1+0.8n_z$

$\lambda_y = (\frac{f_y}{f_{ccy}})^{(1/2)}$

$\lambda_z = (\frac{f_y}{f_{ccz}})^{(1/2)}$

$f_{ccy} = \frac{\pi^2 E}{(KL/ry)^2}$

Check for yielding: (Clause 9.3.1.1)

$$\frac{N}{N_d} + \frac{M_y}{Md_y} + \frac{M_z}{Md_z} \le 1.0$$

where,

$N_d = A f_y/\gamma_{m0}$
$= 2834.09091$ KN $\because \gamma_{m0} = 1.1$ (Table 5, Clause 5.4.1)

$M_{dz} = \beta_b Z_{ez} f_y/\gamma_{m0} < 1.2 Z_{ez} f_y/\gamma_{m0}$ (Clause 8.2.1.2)
$= 400.89$ KN-m < 407.45 KN-m
$\therefore M_{dz} = 400.89$ KN-m

$M_{dy} = \beta_b Z_{py} f_y/\gamma_{m0} < 1.2 Z_{py} f_y/\gamma_{m0}$
$= 314.05$ KN-m < 326.73 KN-m
$\therefore M_{dy} = 314.05$ KN-m

$M_z = 11.1972$ KN-m

$M_y = -13.2521$ KN-m

$\therefore \frac{N}{N_d} + \frac{M_y}{Md_y} + \frac{M_z}{Md_z} = 0.238 < 1$ (OK)

3.3. Design of connections

All the connection design were made following the AISC (American Institute of Steel Construction) Manual. The no. of bolts and their size obtained are directly obtained from the AISC Code.

- Connection Between Beam and Column (8Bolt End Plate Connector)

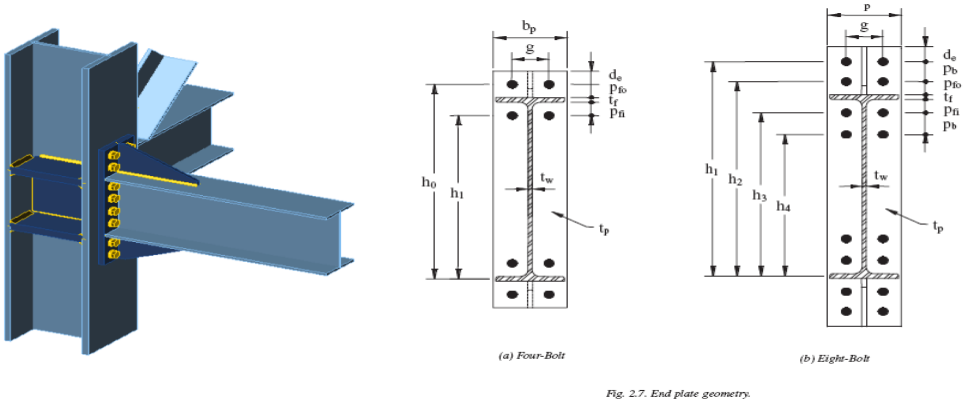


Figure 4: 8 Bolt End Plate Connection

3.4 Beam and Column Splicing

Column splicing is the process of joining the upper column with the lower column when the height of the single column isn't feasible and same with the beams.

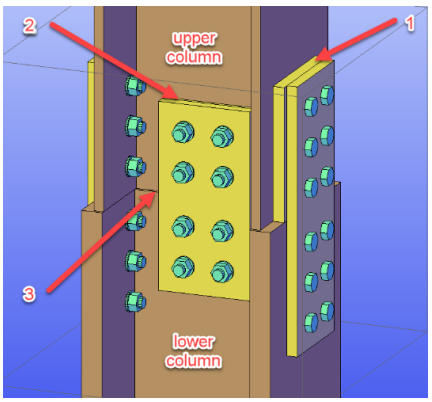


Figure 6: Column Splicing

Figure 5: Beam Splicing

3.5 Battening of Column

Properties:

- 2 ISMC 400 battened column

6 mm batten plate

End Distance of bolt = 35 mm

Pitch Distance of bolt= 55 mm

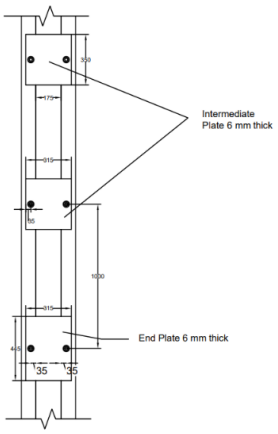
M 20 bolts of grade 4.6

Intermediate batten

- 315 X 350 mm 6 mm plate bolted

End plate

- 315 X 445 mm 6 mm plate bolted.



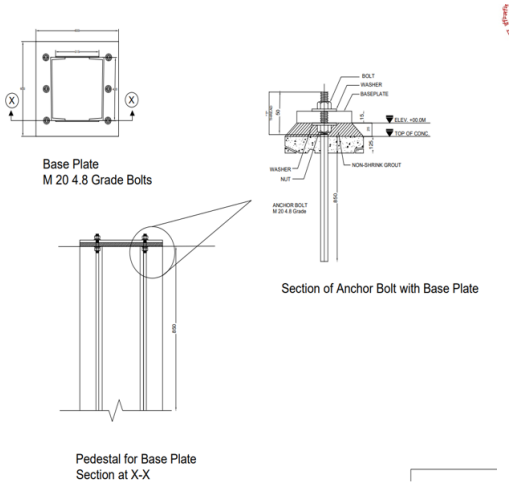
Bracing using M20 4.6 grade bolt

3.6 Base Plate

Properties:

-15 mm thick base plate.

- M 20 bolts of grade 4.8
  - 850 mm deep anchor bolt.
  - Pedestal size 600 X 600 mm



3.7 Results

We designed the model in ETABS V20 and ran the analysis. After assigning the dead loads and effective live loads, the model was run for any irregularities following the National Building Code, NBC 105: 2020.

The test results obtained from the ETABS are:

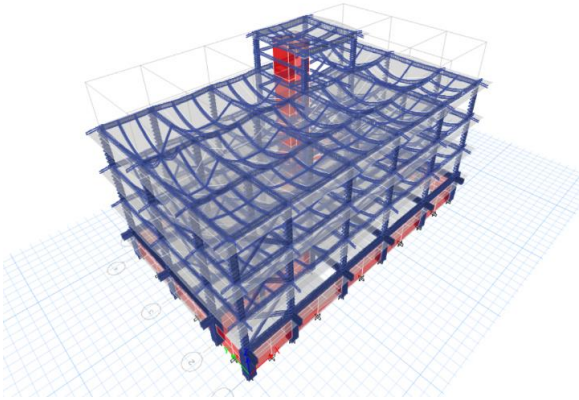


Figure 7: Structural Model

3.7.1 Mass Irregularity Check

According to NBC 105: 2020 Cl. 5.5.1.5, a difference of more than 50% between the masses of two consecutive stories is considered as mass irregularity.

Mass Irregularity Check (As per CL. 5.5.1.5)

Storey Of Building	Mass of Building	Mass < 50% of above or Below Storey		Remarks
		Above	Below	
Story5	95341.38	-	-	
Story4	220311.43	-	-49.92426857	OK
Story3	330300.3	33.2996579	-3.042809831	OK
Story2	340350.71	2.95295697	-49.16169266	OK
Story1	507672.88	32.9586583	-	OK
Base	121695.29	-	-	

3.7.2 Soft Story Check

A Soft story is the one whose stiffness of the lateral forces resisting system is less than 70% of the lateral resisting system in an adjacent story above or below or less than the 80% of the average lateral force resisting system above or below.

Soft Story Check (As per 5.5.1.2)

Storey Of Building	Stiffness(KN/m)	Check		Remarks
		Ki<0.7Ki+1	Ki<0.8K(i+n)/n	
Story5	183332.49	-	-	Top Floor
Story4	257159.56	Ok	Ok	Steel
Story3	396545.23	Ok	Ok	Steel
Story2	859342.64	Ok	Ok	Steel
Story1	4792580	Ok	Ok	RCC Floor

3.7.3 Torsional Irregularity

When the maximum lateral force applied in one end of the story is more than 1.5 times at the far end of the same story.

It should be less than 1.5 times.

Torsional Irregularity (Cl. 5.1.15)								
Storey Level	Story 2		Story 3		Story 4		Story 5	
	Along X-axis	Along Y-axis	Along X-axis	Along Y-axis	Along X-axis	Along Y-axis	Along X-axis	Along Y-axis
Minimum Displacement(Δ_{min})	1.675	6.597	3.791	14.336	5.707	19.267	7.092	18.448
Maximum Dispalcement(Δ_{max})	1.971	6.843	4.262	15.336	5.985	20.517	9.848	22.717
Δmax/Δmin	1.1767	1.037	1.125	1.069	1.048	1.064	1.388	1.231
Allowable (Δmax/Δmin)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok

3.7.4 Inter Story Drift and Displacement

Building Height = 12.5 m from Rigid Basement
Ductility Factor (Rs) = 1 (Cl. 5.3.2 NBC 105:2020) (SLS)
Ductility Factor (Rμ) = 4 (ULS)

Considering Displacement Criteria for Equivalent Static Method from NBC 105:2020

Case i: Eqx ULS
Case ii: Eqy ULS
Case iii: Eqx SLS
Case iv: Eqy SLS

Where,
ULS= Ultimate Limit State
SLS= Serviceability Limit State
Eqx= Earthquake in x-direction
Eqy= Earthquake in y-direction

Maximum Story Displacement ULS

Allowable: (ULS)
Allowable displacement ULS = 0.025H/Rμ = 78.125 mm
Actual Displacement in Eqx= 9.84mm OK
Eqy= 22.71 mm OK

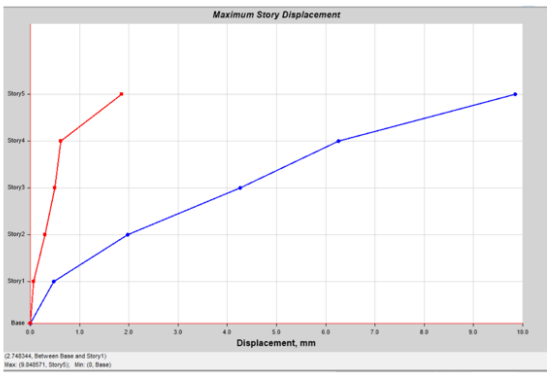


Figure 9: Story Displacement in X-axis

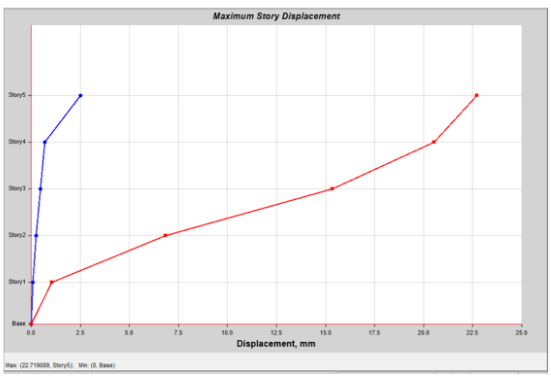


Figure 8: Story Displacement in Y-axis

Maximum Story Displacement SLS

Allowable: (SLS)

Allowable displacement SLS= 0.006H/Rs = 75mm

Actual Displacement in Eqx= 9.45mm OK

Eqy= 21.81 mm OK

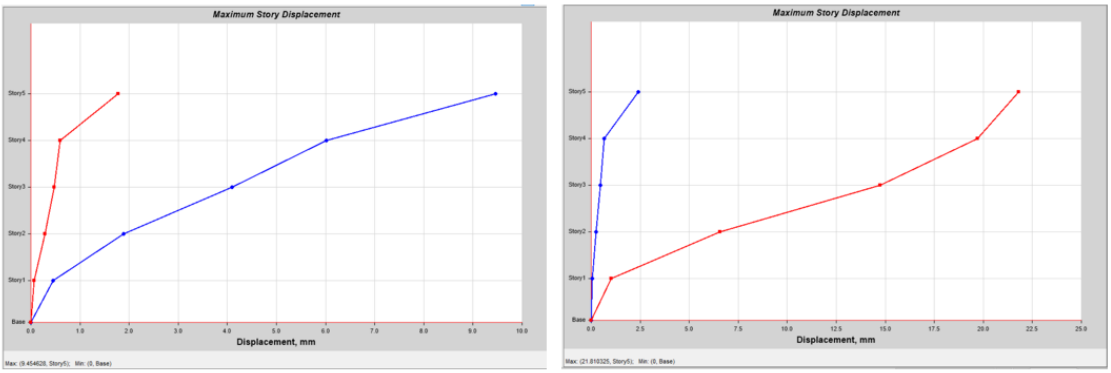


Figure 10: Maximum Displacement in SLS Along X-axis and Y-axis Respectively

Maximum Story Drift (ULS)

Allowable: (ULS)

Allowable drift ULS = 0.025/Rμ = 0.00625mm

Actual Drift in Eq x= 0.00138 mm OK

Eq y=0.002718 mm OK

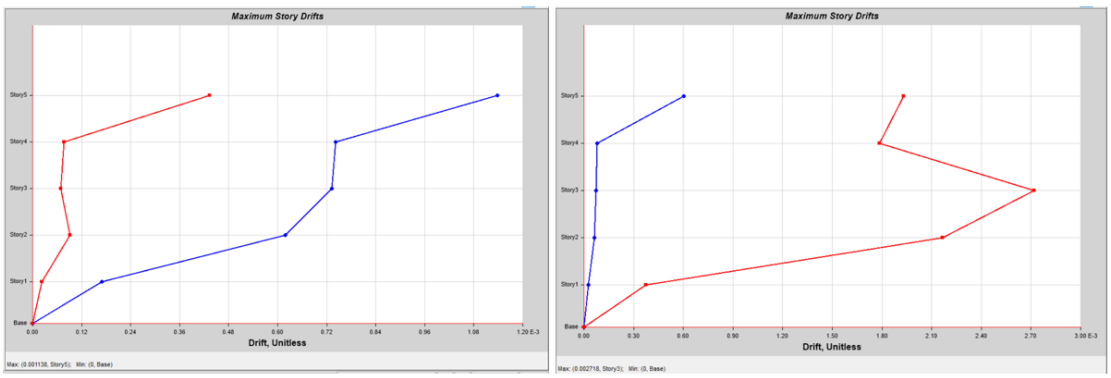


Figure 11:Maximum Story Drift in ULS Along X-axis and Y-axis Respectively

Maximum Story Drift (SLS)

Allowable: (SLS)

Allowable SLS= 0.006

Actual Drift in Eq x= 0.001092 mm OK

Eq y=0.002609 mm OK

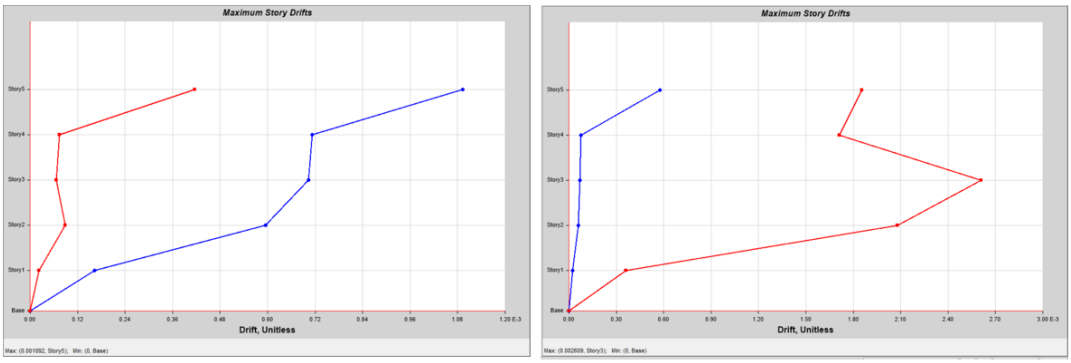


Figure 12:Maximum Story Drift in SLS Along X-axis and Y-axis Respectively

Accidental Eccentricity Check

According to NBC 105:2020, the accidental eccentricity can be taken as ±0.10b. i.e. Should be less than 10%.

Story	ex	ey	Lx	Ly	Accidential EccentricityCheck		Remarks
	m	m	m	m	x%	y%	
Story1	-0.705	0.7184			-2.974683544	5.131428571	OK
Story2	-0.1392	0.8371			-0.587341772	5.979285714	OK
Story3	-0.3684	0.2624	23.7	14	-1.55443038	1.874285714	OK
Story4	-0.0163	-0.1741			-0.068776371	-1.243571429	OK
Story5	1.1615	-0.5328			4.900843882	-3.805714286	OK

4. Conclusion

After the research is completed, the following conclusion was made:

- The steel building has been checked for the seismic load as is designed following the earthquake resistant design.
- The design of the steel connections is also made.
- The torsion induced in the building is balanced by Steel bracing.
- After the completion of the project, we have concluded that the steel building can be designed to resist the earthquake force and can be designed as an alternative of RCC building.
- The project is designed following all the codes and serves without comprising in the structural integrity or safety.
- The displacement of building is within the permissible range along both axes. There is no difference in mass more than 50% between two consecutive stories. Hence, mass irregularity doesn't exist in our building.

So, if designed following all the codes the steel building can be an alternative to the traditional RCC style building. If steel building is designed then it also reduces the construction cost also.

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A STUDY ON TRAVEL TIME, DELAY AND TRAFFIC DATA ANALYSIS IN GUFA-CHOREPATAN ROUTE OF POKHARA

Prakriti Kuikel, Purnima Adhikari, Roshani Dhungana , Sophya Pokhrel , Yam Bahadur Thapa
Department of Civil Engineering, Pokhara Engineering College, Pokhara University
Corresponding email: prakritikuikel77@gmail.com

Abstract

This study focuses to carryout travel time, delay and their causes including passenger data analysis. We have evaluated the status of service provided by public transportation selected route. The significance of our study is to evaluate travel pattern, travel time, delay and level of service provided by public vehicles. Manual and Test Vehicle methods of survey are carried out on morning off, morning peak, day off and day peak hour for 3 consecutive mid days of week. Among 24 routes of Pokhara only one route i.e. Gufa-Chorepatan has been our study area considering higher number of bus allocation. For analysis purpose we used Google Earth Pro, GIS, SPSS, MS Excel, etc. From this study we have found that travel time significantly rises due to delays which have affected the expected speed of vehicle, and unnecessary time of productive minds. From delay analysis, we found that more than 50% of delay are caused due to intermediate delay. Passenger flow have significantly been varied during peak and off-peak hours. So, constant schedule seems ineffective which should be addressed soon. Passenger's perception on public vehicle has been carried out from selected 90 respondents. People express quite positive response on seat comfort, fare rate, staff's behavior but for overall comfort during travelling people have mixed thoughts and supposed to be unsatisfactory. After reliability check we found this data reliable. Through road capacity analysis segments (Mahendrapul-Palikhechowk, Damside-Srijanachowk) needs 4 lane road.

Keywords: Delay, GIS, People, Road, Travel time

1 Introduction

Transportation boosts economic growth, market access, agricultural productivity, social connectivity, business development, and job opportunities, reducing isolation and poverty.

Travel time, defined as the duration needed to journey between two points, can be measured by traversing the route. It includes two key components: running time; when the vehicle is in motion, and delay time; when it is either stopped or moving extremely slowly (typically under 8 kph or 5 mph). Efficient transportation ensures smoother, faster travel, opening doors to greater economic and social possibilities.

1.1 Travel Time Study

Travel time, defined as the duration to traverse a street segment, provides essential data for calculating average speeds and evaluating roadway performance. It helps traffic engineers assess system efficiency, focusing on travel time, speed, and delay metrics for planning and analysis.

1.2 Delay Studies

Delay refers to extra time drivers spend beyond normal travel time due to obstacles like traffic congestion or control devices. Studies measure delay's cause, location, duration, and rate, alongside travel time, to evaluate its impact on road efficiency.

1.3 Purpose of Travel Time and Delay Studies

The Travel time and delay study aims to evaluate the quality of traffic movement along the route and determine the locations, types, and extent of traffic delays by using a moving test vehicle.

- This technique has comparable operational conditions before and after the roadway or road crossing improvement. However, it is used as a tool to assist in prioritizing projects by assessing the level of operational deficiencies (like delays and stops) for each project under consideration.
- The Travel time and delay study can be used by the planners to monitor the level of service.

This survey method gives the engineer quantitative information with which he can suggest recommendations for improvement of traffic signal re-timing, safety improvements, turn lane additions, and channelization enhancements.

1.4 Methods of travel time survey

Each method has its strengths and weaknesses, and the choice of method depends on the survey's objectives, budget, and the specific context of the study area.

1.4.1 Test Vehicle Technique

Test vehicle techniques, or the "floating car" method, are commonly used for travel time data collection. A vehicle moves with regular traffic, adhering to set speed guidelines like "average car" or "floating car". Data can be recorded manually at checkpoints or through advanced technology such as electronic Distance Measuring Instruments (DMI) or GPS systems. These devices, linked to a computer, can capture speed, travel times, and distances at frequent intervals, offering precise and detailed travel time data for analysis.

1.4.2 License Plate Technique

Travel time data collection captures vehicle license plates and arrival times at checkpoints to calculate trip durations. Methods range from manual entries using voice recorders or portable computers to efficient video-based systems. Advanced character recognition software automates license plate matching, enhancing speed, accuracy, and reliability for precise travel time analysis.

1.4.3 Emerging and Nontraditional technique

Emerging and non-traditional travel time collection techniques, like inductance loops, weigh-in-motion stations, and aerial video, are being researched and tested. Though still in developmental stages and not widely field-tested, they show promise for future use. As these methods evolve, future editions of this handbook will offer more detailed insights.

1.4.4 ITS Probe Vehicle technique

ITS probe vehicle techniques use passive vehicles, such as personal or commercial, to collect real-time travel data via GPS, transponders, and radio navigation. This data, sent to a transportation center, enhances route guidance, toll collection, and security applications.

1.5 Traffic Counting

Traffic counts assess road usage, vehicle classification, and occupancy, especially for HGVs. Accurate data requires long durations, seasonal counts, and high volumes. In rural areas, including non-motorized transport and local knowledge ensures comprehensive counts, covering pedestrians and bicycles.

1.6 Passenger Car Units

The Passenger Car Unit (PCU) standardizes vehicle impact on traffic flow, converting various vehicle types into equivalent passenger cars. By analyzing PCU values and travel time data, planners can optimize infrastructure, identify congestion points, and improve traffic management strategies.

Table 1: Vehicle Type and their PCU factor

SN	Vehicle Type	Equivalency Factor
1	Bicycle, Motorcycle	0.5
2	Car, Auto Rickshaw, SUV Light Van and Pick up	1
3	Light (Mini) Truck, Tractor, Rickshaw	1.5
4	Truck, Bus, Minibus, Tractor with trailer	3
5	Non-motorized carts	6

Source: NRS-2070

1.7 Capacity of Road

Road capacity, measured in PCU/Day, represents the maximum number of equivalent passenger cars a road can handle in 24 hours. It accounts for lane width, traffic flow, intersections, and vehicle types. These metrics guide road design, maintenance, and traffic management, optimizing performance and ensuring safety in transportation networks.

Table 2: Capacity of Roads, PCU/day

SN	Category	Plain		Rolling		Mountainous and steep	
		Low curvature (0-50 deg|km)	High curvature (>50 deg|km)	Low curvature (0-50 deg|km)	High curvature (>50 deg|km)	Low curvature (0-50 deg|km)	High curvature (>50 deg|km)
1	Single lane road (3.75m) with good quality shoulders at least 1m wide	2000	1900	1800	1700	1600	1400
2	Intermediate lane road(3.75m) with good quality shoulders at least 1m wide	6000	5800	5700	5600	5200	4500
3	Double lane road(7m) with good quality shoulder at least 1m wide	15000	12500	11000	10000	7000	5000
4	Four lane road with minimum 3m wide median	40000	35000	32500	30000	25000	20000

Source: NRS-2070

1.8 Satisfaction Survey

A structured questionnaire survey collects data on passengers' satisfaction with bus services, assessing factors like travel time reliability, comfort, convenience, safety, and fare to understand public perception of public transportation.

1.9 Geographic Information System

GIS integrates and analyzes spatial data, helping planners map routes, study traffic patterns, and forecast demand. It enhances route planning, manages passenger flows, and supports evidence-based policies for efficient, congestion-reducing urban transportation systems.

2. Materials and Methods

2.1 Introduction to Study Area

The Gufa-Chorepatan route, which passes through core area of Pokhara Metropolitan City, was chosen for our study. Stretching over 12.560 km, this bustling route connects key landmarks like Bagar, Mahendrapul, Chipledhunga, Savagriha, Srijanachowk, Rastrabankchowk, and Birauta, while also integrating major national highways such as the Siddhartha Highway and Pushpalal Highway.

This route stands out for its high frequency of public buses, predominantly operated by Pokhara Yatayat Pvt. Ltd. and Fewa Yatayat Pvt. Ltd., which serve a variety of routes within Pokhara. Among the 24 public transport routes in the valley, this route is a vital artery, making it an ideal focus for our study on travel time and delay.

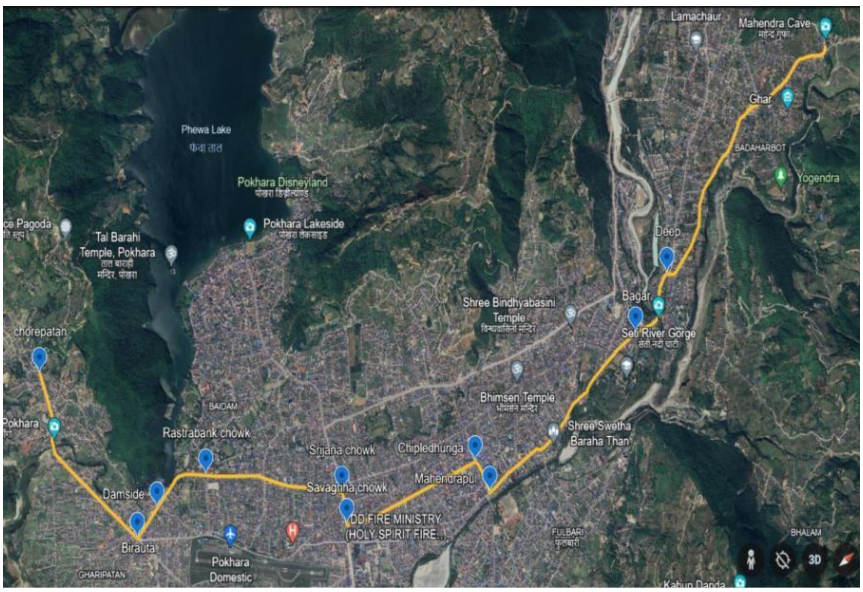


Figure 1: Representation of study area through Google Earth

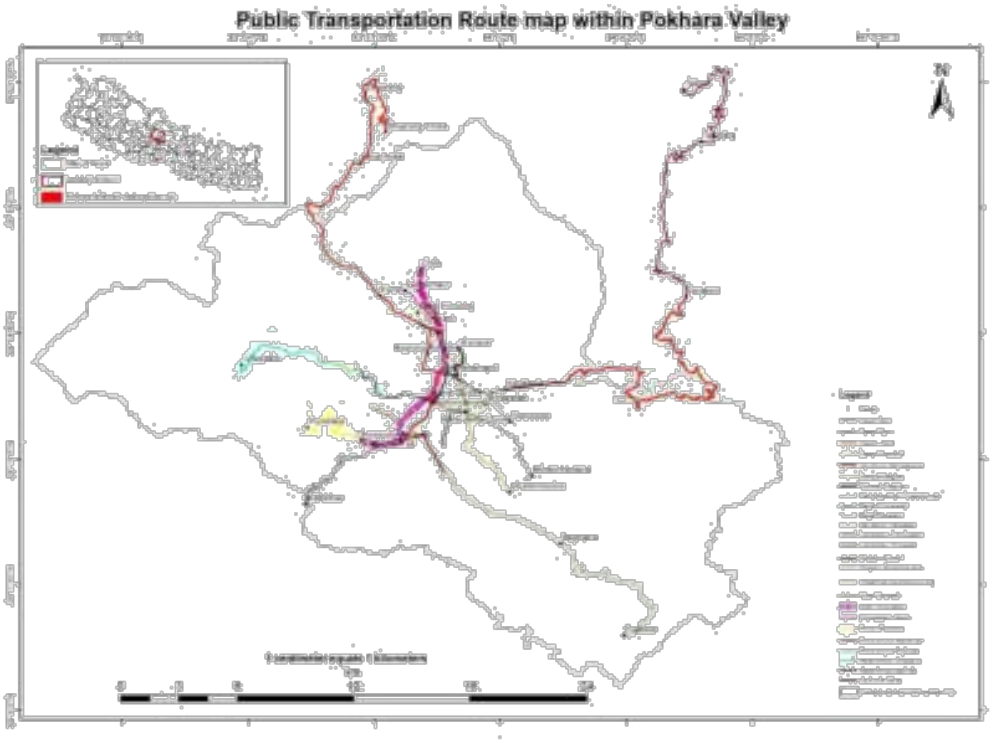


Figure 2: Public Transportation Route Map within Pokhara Valley

2.2 Methodology

The travel time study was conducted through a detailed literature review, site assessments, and a thorough survey of individuals using public transportation. Utilizing the test vehicle method, we measured the average speeds of vehicles on designated routes to evaluate travel times, pinpoint delays, and investigate their causes. From floating car method, we calculate the capacity of road and required number of lanes. A carefully designed questionnaire was developed to gather insights into public perceptions of the transportation system, collecting feedback from 90 passengers. This methodology yielded valuable data for analyzing the efficiency and user experience of the transit system.

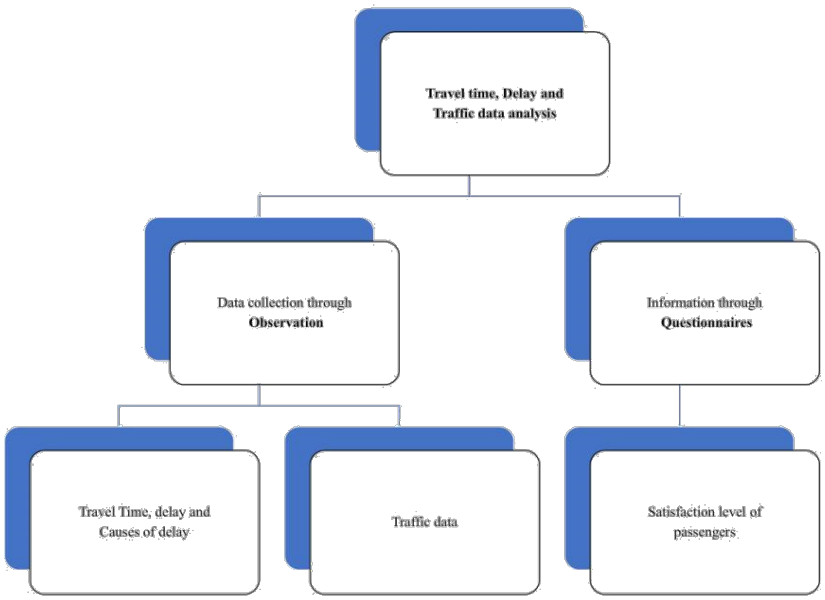


Figure 3: Methodology during the study of travel time, delay and traffic data analysis

3 Results and Discussion

3.1 Average Speed

During this research survey, we found the average travel speed in the forward direction (Chorepatan – Gufa) to be 12.29 kmph, and similarly in the reverse direction (Gufa – Chorepatan) to be 12.83 kmph.

3.2 Travel Time

Since the speed in both reciprocal directions was nearly equal, the speed of the test vehicle for the travel time survey was maintained at 12 kmph in both directions. The test vehicle made a total of 24 trips in forward and reverse directions. The average volume from Chorepatan to Gufa was found to be 11.93 vehicles per minute, and from Gufa to Chorepatan, it was found to be 12.02 vehicles per minute. The average journey time from Chorepatan to Gufa and Gufa to Chorepatan was found to be 28.6 minutes and 27.33 minutes, respectively. Here, we could deduce that, since the test vehicle was operated at the average speed (around 12 kmph) including delays, the travel time during the survey was nearly one hour. From the calculations, we can see that the journey time on

the route could have been around 28 minutes if delays were relatively less. Hence, the effect of delay during the trip results in changes in total travel time.

3.3 Delay

From the delay studies and analysis, it was found that delay in the forward direction (Chorepatan – Gufa) was composed of 72% intermediate delay, 27% passenger delay, and 1% other delay. Similarly, in the reverse direction (Gufa – Chorepatan), the delay was 53% intermediate delay, 41% passenger delay, and 7% other delay. Thus, more than 50% of the delay was caused by intermediate delays. During off-peak hours, intermediate delay seems to be higher, whereas passenger flow delay and other delays contribute less. Similarly, during peak hours, passenger flow delay and other delays contribute more, including intermediate delay.

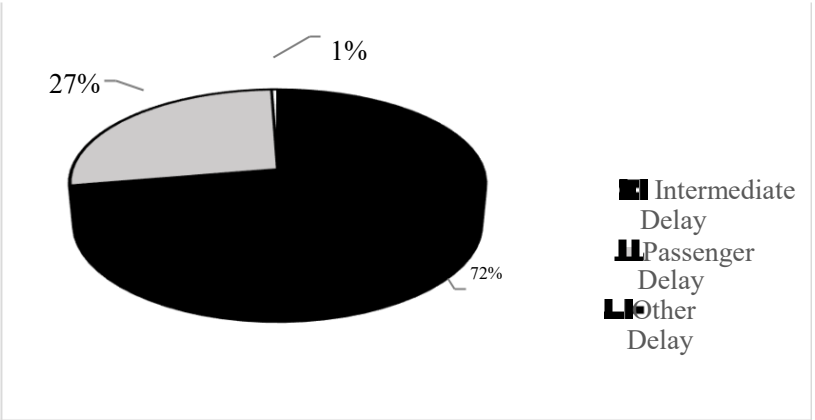


Figure 4: Pie chart representing delay in Forward Direction

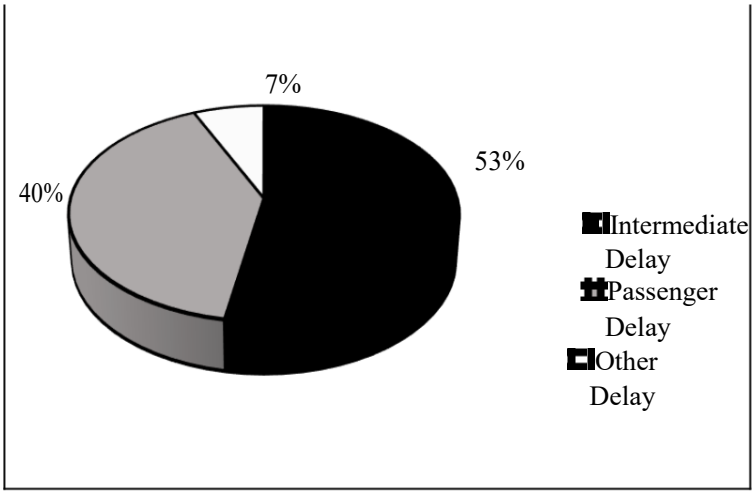
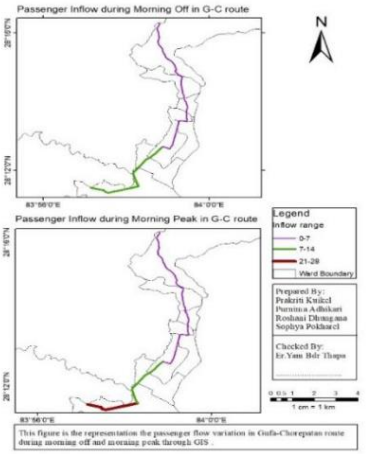
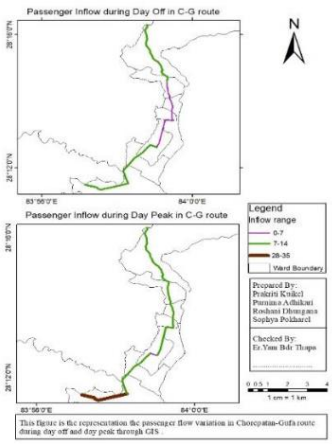


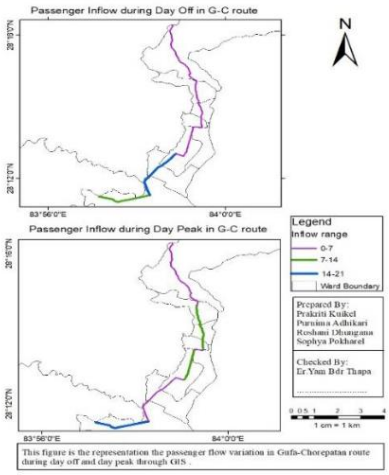
Figure 5: Pie chart representing delay in Reverse Direction

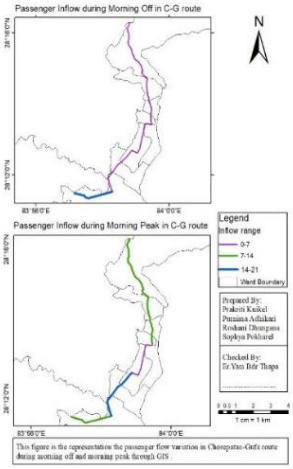
3.4 Passenger Flow

From the passenger flow exploration, it was found that the volume of passengers varies significantly between peak and off-peak hours. During the morning peak hour, passenger flow towards city areas like Bagar, Mahendrapul, Chipledhunga, Srijanachowk, and Birauta seems to be very high, whereas during the day peak hour, passenger flow away from city areas seems to be very high. The seat capacity of buses allocated by Pokhara Yatayat on that specific route was found to be 30 seats on average. During peak hours, the seats seem to be over-occupied, and during off-peak hours, the seats were quite empty.


Passenger Inflow during Morning Off in G-C route
Passenger Inflow during Morning Peak in G-C route
Legend
Inflow range
0-7
7-14
21-28
Ward Boundary
Prepared By:
Prakriti Kuikel
Purnima Adhikari
Roshani Dhungana
Sophiya Pokharel
Checked By:
Er.Yam Bdr Thapa
1 cm = 1 km
This figure is the representation the passenger flow variation in Gufa-Chorepatan route during morning off and morning peak through GIS .


Passenger Inflow during Day Off in C-G route
Passenger Inflow during Day Peak in C-G route
Legend
Inflow range
0-7
7-14
28-35
Ward Boundary
Prepared By:
Prakriti Kuikel
Purnima Adhikari
Roshani Dhungana
Sophiya Pokharel
Checked By:
Er.Yam Bdr Thapa
1 cm = 1 km
This figure is the representation the passenger flow variation in Chorepatan-Gufa route during day off and day peak through GIS .


Passenger Inflow during Day Off in G-C route
Passenger Inflow during Day Peak in G-C route
Legend
Inflow range
0-7
7-14
14-21
Ward Boundary
Prepared By:
Prakriti Kuikel
Purnima Adhikari
Roshani Dhungana
Sophiya Pokharel
Checked By:
Er.Yam Bdr Thapa
1 cm = 1 km
This figure is the representation the passenger flow variation in Gufa-Chorepatan route during day off and day peak through GIS .


Passenger Inflow during Morning Off in C-G route
Passenger Inflow during Morning Peak in C-G route
Legend
Inflow range
0-7
7-14
14-21
Ward Boundary
Prepared By:
Prakriti Kuikel
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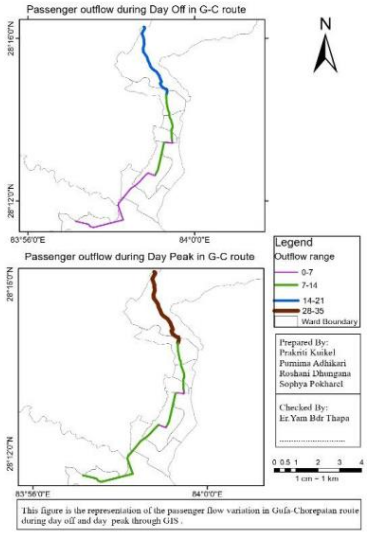
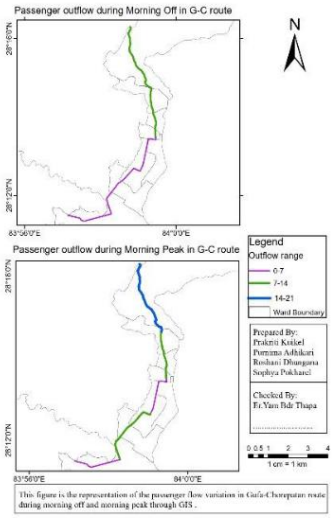
Sophiya Pokharel
Checked By:
Er.Yam Bdr Thapa
1 cm = 1 km
This figure is the representation the passenger flow variation in Chorepatan-Gufa route during morning off and morning peak through GIS .


Passenger outflow during Day Off in G-C route
Passenger outflow during Day Peak in G-C route
Legend
Outflow range
0-7
7-14
14-21
28-35
Ward Boundary
Prepared By:
Prakriti Kuikel
Purnima Adhikari
Roshani Dhungana
Sophiya Pokharel
Checked By:
Er.Yam Bdr Thapa
1 cm = 1 km
This figure is the representation of the passenger flow variation in Gufa-Chorepatan route during day off and day peak through GIS .


Passenger outflow during Morning Off in G-C route
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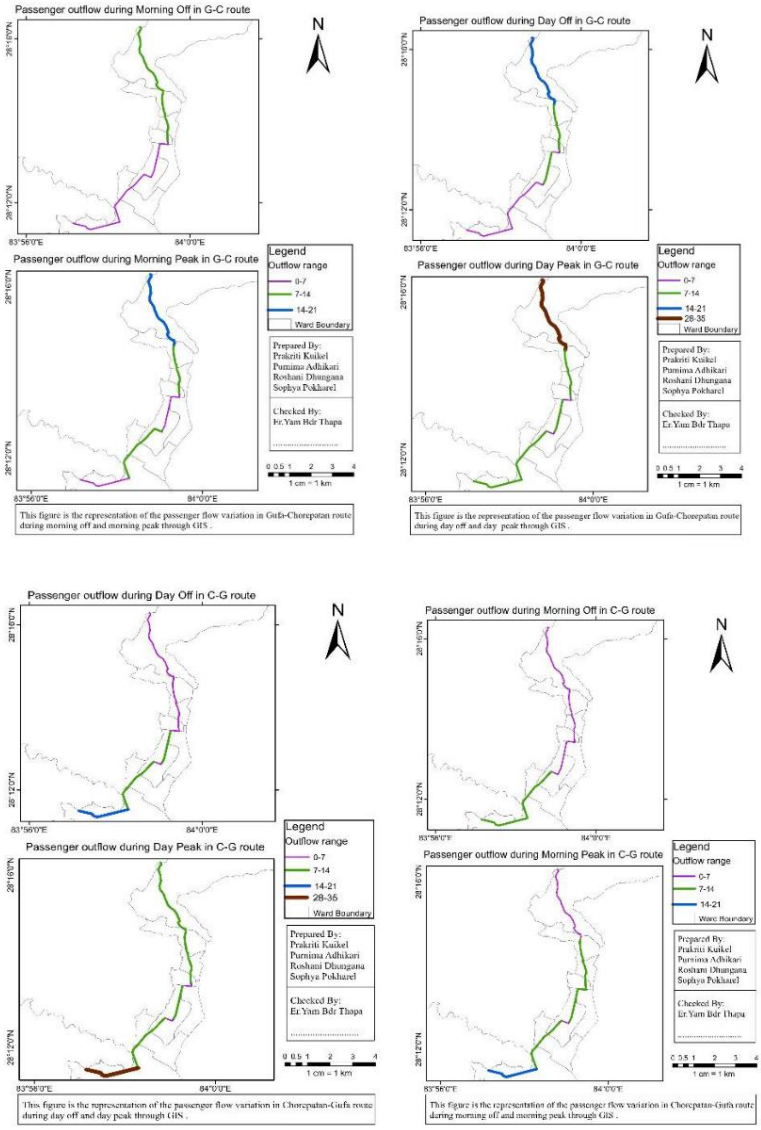

Figure 6: Representation of passenger Inflow and Outflow in Forward and Reverse direction through GIS

3.5 Passenger Perception

To understand people's perspectives on public transportation, data from 90 respondents were collected. The responses on seat comfort, staff behavior, and fare rates were found to be quite positive, whereas the response on overall comfort during travel was found to be quite unsatisfactory, as most people experienced unusual delays during their trips.

Table 3: Data for passenger's evaluation for seat comfort

SN	Evaluation	Respondent
1	Excellent	0
2	Good	60
3	Satisfactory	30
4	Poor	0
5	Very Poor	0
	Total	90

Table 4: Data for passenger's evaluation for comfort in travelling

SN	Evaluation	Respondent
1	Excellent	0
2	Good	17
3	Satisfactory	27
4	Poor	46
5	Very Poor	0
	Total	90

Table 5: Data for passenger's evaluation for staff behaviors

SN	Evaluation	Respondent
1	Excellent	0
2	Good	57
3	Satisfactory	18
4	Poor	7
5	Very Poor	8
	Total	90

Table 6: Data for passenger's evaluation for travelling fees

SN	Evaluation	Respondent
1	Excellent	11
2	Good	29
3	Satisfactory	23
4	Poor	23
5	Very Poor	4
	Total	90

3.6 Reliability Analysis

From the reliability analysis through SPSS, the Cronbach's Alpha was found to be 0.695. Therefore, the passenger reviews were found to be reliable.

3.7 Road Capacity

After converting the number of vehicles into PCUs from traffic data, we calculated the capacity of the lane by dividing the PCU by travel time. From the road capacity analysis (NRS 2070), it was found that every segment needs a 4-lane road with a 3-meter-wide median, except for the Bagar-Gufa segment, which requires a 2-lane road.

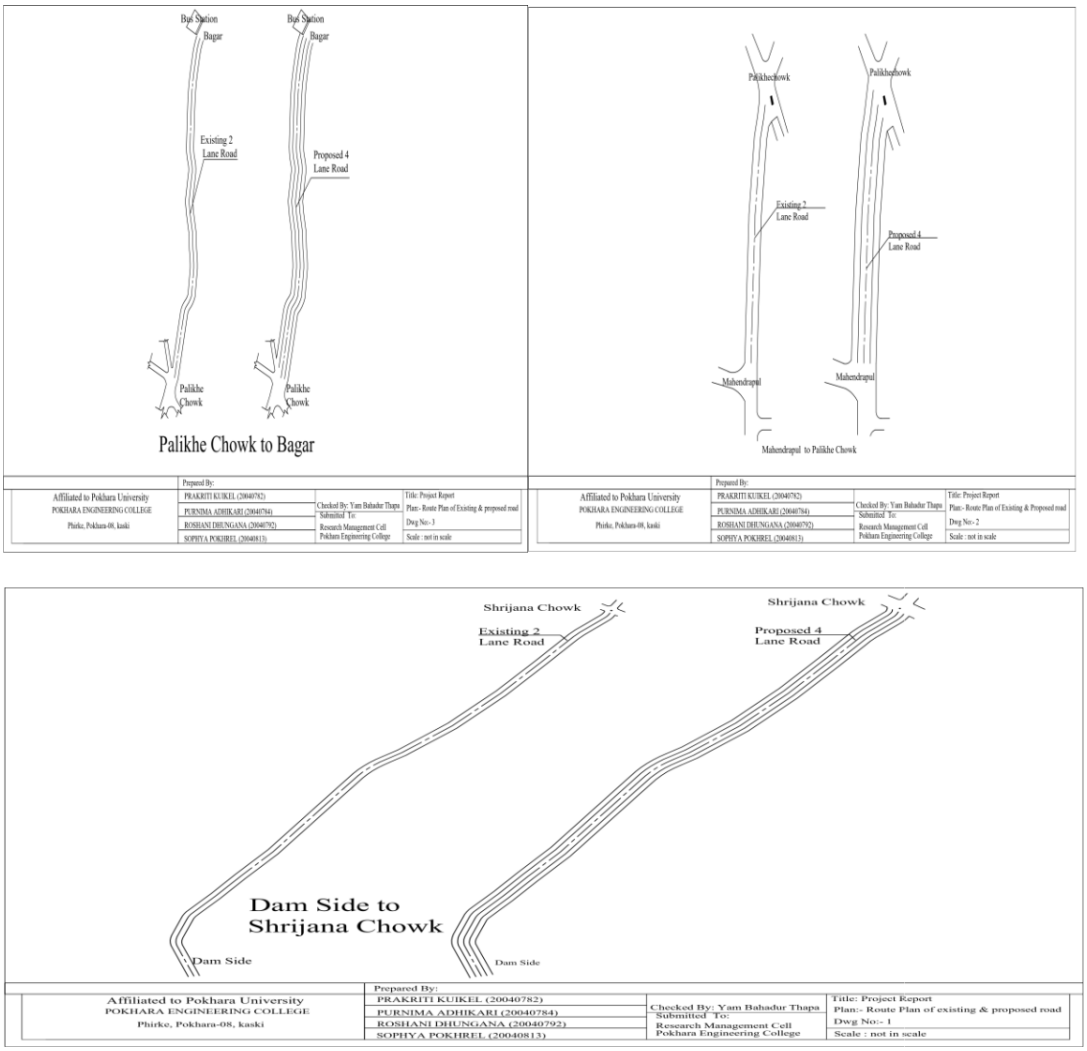

Figure 7: Representation of existing lanes along with required Lanes

4 Conclusion

From the study of travel time survey, delay, traffic data, and evaluation of public transit services being provided in the Gufa-Chorepatan route of Pokhara Valley, it could be portrayed that travel time varies notably based on delays, passenger flow, and service conditions. The theoretical average journey time of approximately 28 minutes and practical average journey time of 1 hour indicate that delays significantly impact total travel time, particularly during peak hours when passenger and intermediate delays are more distinct. To boost efficiency and keep down inessential delays, this study highlights the necessity of thoroughly applying rules against random stoppage, utilizing facilities like bus stops and terminals. Furthermore, the fluctuating passenger mass

focuses attention on the importance of modifying service frequency to better line up with demand, securing a productive transit exposure. Eventually, labeling these components is crucial to upgrade passenger comfort and satisfaction, highlighting the essential requirement for transit service providers to make alterations to their approach correspondingly.

Acknowledgement

We would like to convey our unfeigned gratitude to our research supervisor, Er. Yam Bahadur Thapa, for his consistent advice and assistance throughout this journey. His expertise, encouragement, and experience have been a strong foundation for this research. Similarly, we are grateful to our Coordinator-Research Management Cell, Er. Krishna Ghimire sir, and the overall Department of Civil, Pokhara Engineering College, for their support in providing the resources needed to complete this task. Last but not least, we would like to acknowledge every single helping hand who has visibly or invisibly assisted in this research.

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SEISMIC ANALYSIS AND DESIGN OF MULTI-STORIED APARTMENT BUILDING

Sabina Poudel, Sabina Subedi, Aasha Dahal, Sadhana Sapkota, Shreemaya Gurung, Krishna Ghimire
Department of Civil Engineering, Pokhara Engineering College, Pokhara University
Corresponding email: krishnaghimire030@gmail.com

ABSTRACT

This paper presents study of seismic analysis and design of Middle Rise Apartment Building using the latest Indian Code; IS 1893: 2016. Material properties are assumed as per the common practice and similarly the soil bearing capacity is also assumed suitably. SAP 2000 Vs. 20 has been used for detailed analysis of structure. Loads and Earthquake forces are applied as per the code of Indian Standard as well as Nepal Building Code was referred. The design of the elements is done by using limit state design philosophy considering economic, safe and reliable. Ductile detailing is done as per IS 13920:2016 and SP16. The displacement value of our building was found to increase simultaneously with the increase in height of building. The maximum horizontal displacement of any floor was not found to exceed 1.4 times its minimum horizontal displacement at another end of same floor. Thus, the building was safe against twisting moment. The resulting value of base shear obtained manually and from Sap analysis was found to be similar.

Key words: Seismic Analysis, Drift, Displacement, Torsion, Limit state, Ductile Detailing,

1.Introduction:

Building means a place where we live. It provides us the space to do works and reflects the social, economic, cultural and other aspects of the whole area. Once a building is constructed, it remains for several years. So, it is most important to have a good planning before constructing any building. The growth of population in the world especially in major cities has created many problems of land settlement. Therefore, it has become necessary to build multi-storied apartment buildings. Constant rise in demand of building houses to accommodate people gets limited due to limited availability of land. Renting apartments helps to solve the problem of providing housing to people. Furthermore, the ever-increasing density in urban area demands the development of multi-storied

apartment buildings. Hence, from economic as well as environmental point of view, apartment buildings provide great solution to both population demand and limitation of land.

Apartment buildings provide housing facilities to different families living independently of each other in a same building. Since shelter is one of basic human needs, apartment buildings are solely focused on providing shelter accommodations and related services to many families simultaneously. Lack of development pace in rural parts of Nepal has resulted people to migrate into urban areas to get better opportunities and improved quality of life. Better opportunities of self-employment, health facilities, education and other facilities is attracting majority of rural population to migrate. Although the population keeps increasing in urban areas, there is limited land to provide housing facilities. In order to cater growing population's housing needs, multi-storied buildings in the form of apartment housings are being developed.

Furthermore, Nepal is situated in sub-duction zone of two tectonic plate called Indian and Tibetan plate. The Indian plate is moving towards the Tibetan plate 2cm per year. The existence of Himalayan range with the world's highest peak is the evidence of high tectonics beneath the country. As a result, Nepal lies in an active seismic zone. Thus, Pokhara is prone to earthquake hazards too since Pokhara lies on the zone 5, the severest one. Hence, the effect of earthquake is pre-dominant than the wind load. So, the design of earthquake resistance structure is mandatory.

1.1 Objectives:

The main objective of our project was:

To carry out seismic analysis, and design of multi-storied apartment building.

2. Building Description:

The site of the project is selected in Talchowk, Pokhara-Lekthnath where our proposed building is designed as a multi-storied apartment building. It is a sixth storey building with earthquake resisting property in focus. The construction was done as per IS Code. The salient features of our project are as follows:

i. Type of building : Medium Rise Apartment Building

ii. Structure system : Special RC Moment Resisting frame structure (SMRF)

iii. Plinth area : 2104.55 sq. ft.

iv. No. of storey : 5Storey + Staircase Cover

v. Floor to floor height : 3m for all floors

vi. Type of Slab : Two-way Slab

vii. Type of Beam : Main (300mm×500mm), Secondary (300*350)

viii. Type of Column : Square

ix. Types of Foundation : Isolated foundation

x. Type of Staircase : Open well staircase

xi. Materials : Cement, Brick, Sand, Rebar etc.

xii. Concrete : M25 for column, beam, slab, foundation

xiii. Steel grade (f_y) : Fe500

xiv. Soil Type : Medium Soil with SBC of 150 KN/m^2

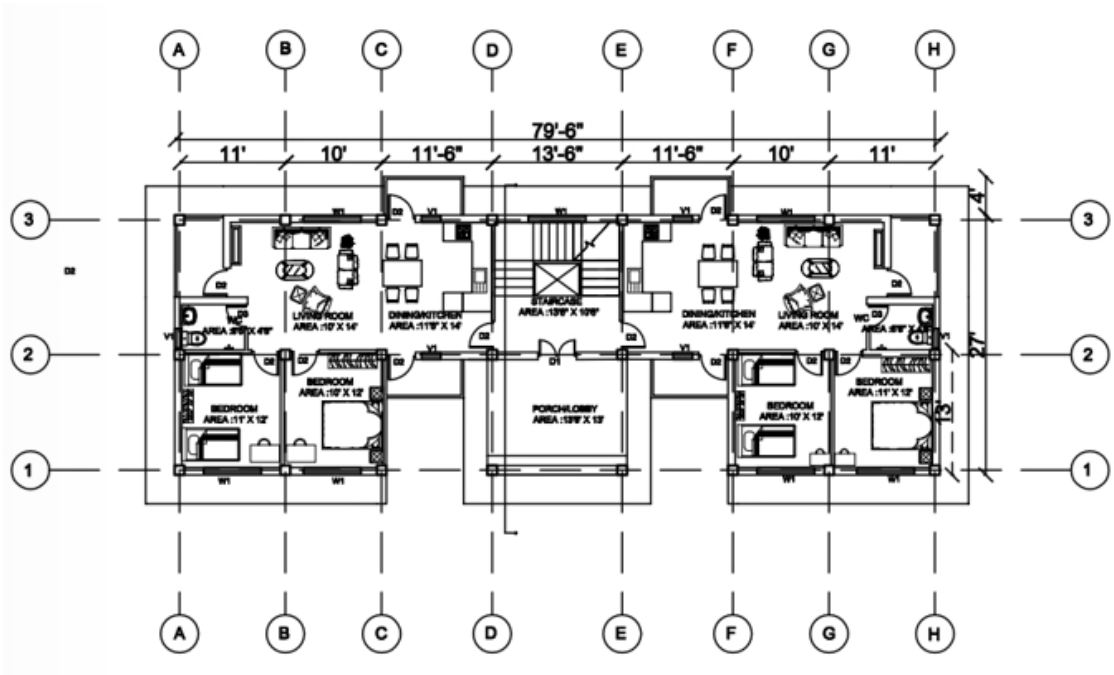

Figure 1 : Ground floor plan

3. Methodology:

3.1 Identification of Load:

Table: 1 Dead Load Used in the analysis; Dead Load (DL): As per IS Code 875-1987(part 1)

PARAMETERS	DEAD LOAD
One brick thick External wall Without Opening	13.25 KN/m
One brick thick External wall 25% Opening	10.25 KN/m
Half brick thick External wall With Opening	6.5 KN/m
Dead load of Floor finish for Roof	0.5 KN/m^2
Dead load of Floor finish without Marble	0.75 KN/m^2
Dead load of Floor finish with Marble	0.65 KN/m^2

Table: 2 Live Load in analysis; Imposed Loads: As per IS Code 875-1987 (part 2)

PARAMETERS	LIVE LOAD
Balcony, staircase, lobby, office room without separate storage	4 KN/m^2
Kitchen, conference hall	3 KN/m^2
Office room with separate storage	2.5 KN/m^2
Toilet, bathroom	2 KN/m^2
Roof accessible	1.5 KN/m^2
Roof not accessible	0.75 KN/m^2

As per IS 1893: 2016 the structure should be designed for the given load combinations

$\pm EL_X \pm 0.3\ EL_Y\}]$ and 1

$\pm 0.3EL_X \pm EL_Y\}]$ 2

Where X and Y are two orthogonal horizontal plan directions. Thus, EL in the load combinations given above shall be replaced by ($EL_X \pm 0.3\ EL_Y$) or ($EL_Y \pm 0.3\ EL_X$). Hence, the sets of load combinations to be considered shall be as given below:

$1.2[DL+IL\pm[\{\ EL_X \pm 0.3\ EL_Y\}]$ and 3

$1.2[DL+IL\pm[\{\ EL_Y \pm 0.3\ EL_X\}]$; 4

$1.5[DL\pm[\{\ EL_X \pm 0.3\ EL_Y\}]$ and 5

$1.5[DL\pm[\{\ EL_Y \pm 0.3\ EL_X\}]$; 6

$0.9[DL\pm 1.5[\{EL_X \pm 0.3\ EL_Y\}]$ and 7

$0.9[DL\pm 1.5[\{EL_Y \pm 0.3\ EL_X\}]$ 8

3.2 Modeling/Analysis:

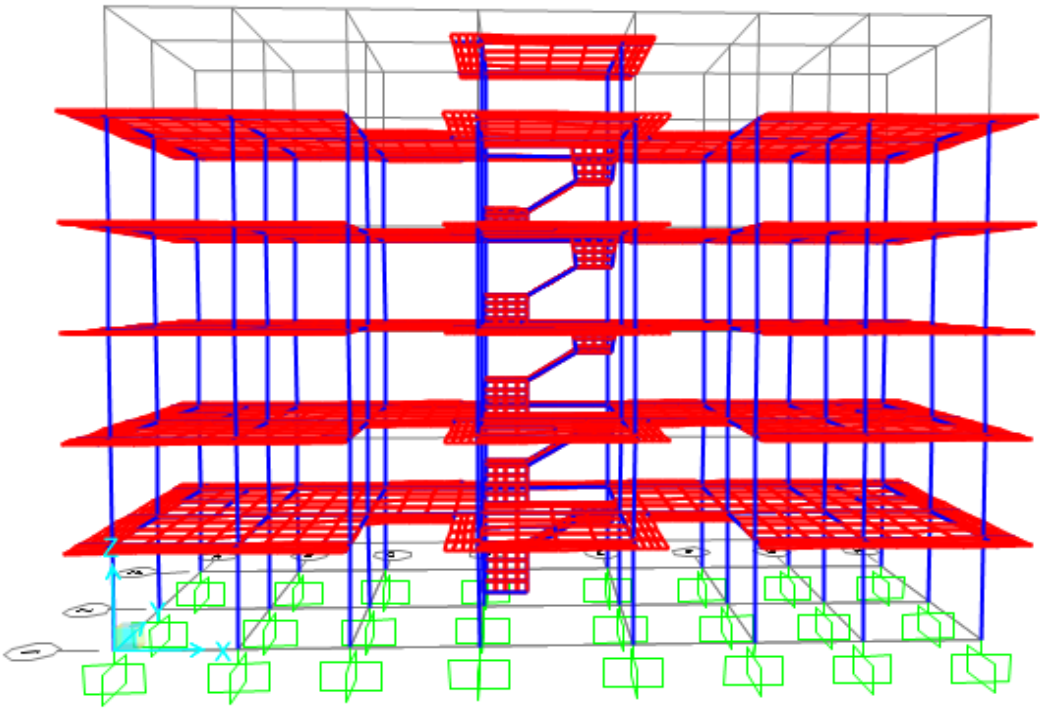

Figure 2 : Elevation View of SAP model

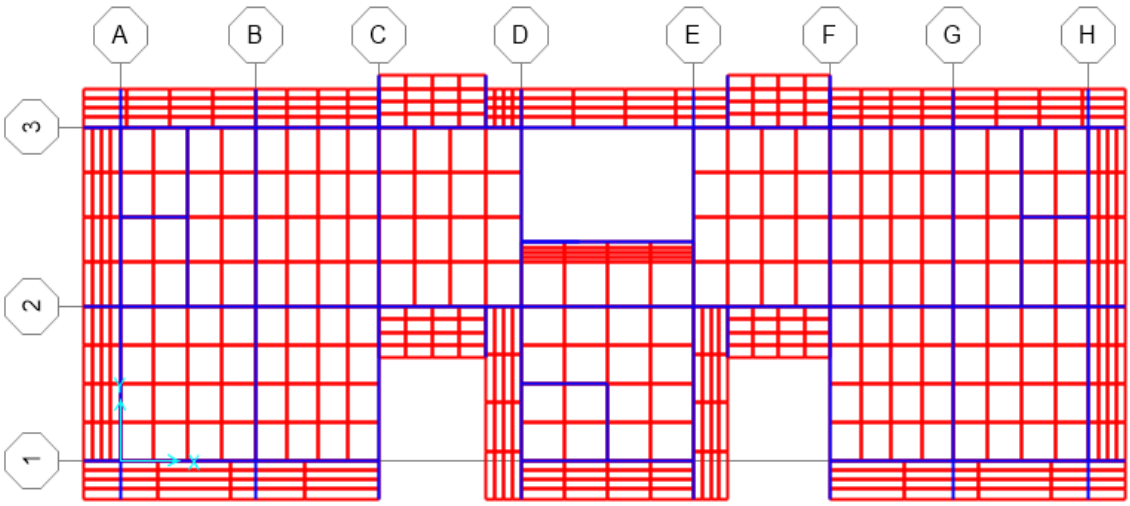

Figure 3: Elevation View of SAP model

4. Result and Discussion:

The RC framed apartment building with different stories were studied as shown in figure. The building was modeled the software SAP2000. The beam and column were modeled as linear element, slab was modeled as shell element. To account in plane stiffness of the RC floor system, rigid diaphragm modeling was done.

Inter story drift and displacement data obtained from SAP:

Displacement

It is the displacement of any floor with respect to the ground, as displacement in ground is generally assumed to be 0 in both x and y direction.

Inter story drift

It is the relative displacement of one floor with respect to the other floor. Determination of the drift is essential in predicting the diaphragm as flexible, semi-rigid or rigid, that is important during defining constraints in SAP.

Table: 3 Displacement and drift in X- direction

Height from ground Z (m)	Displacement in X-direction (mm) U1	Inter-Story Drift in X –direction (mm)	Remarks
18	35.3088	0.00083	Storey drift in any storey shall not exceed 0.004 times the storey height
15	30.550	0.0011	
12	26.755	0.00098	
9	20.835	0.00074	
6	13.554	0.00047	
3	5.8335	0.00012	

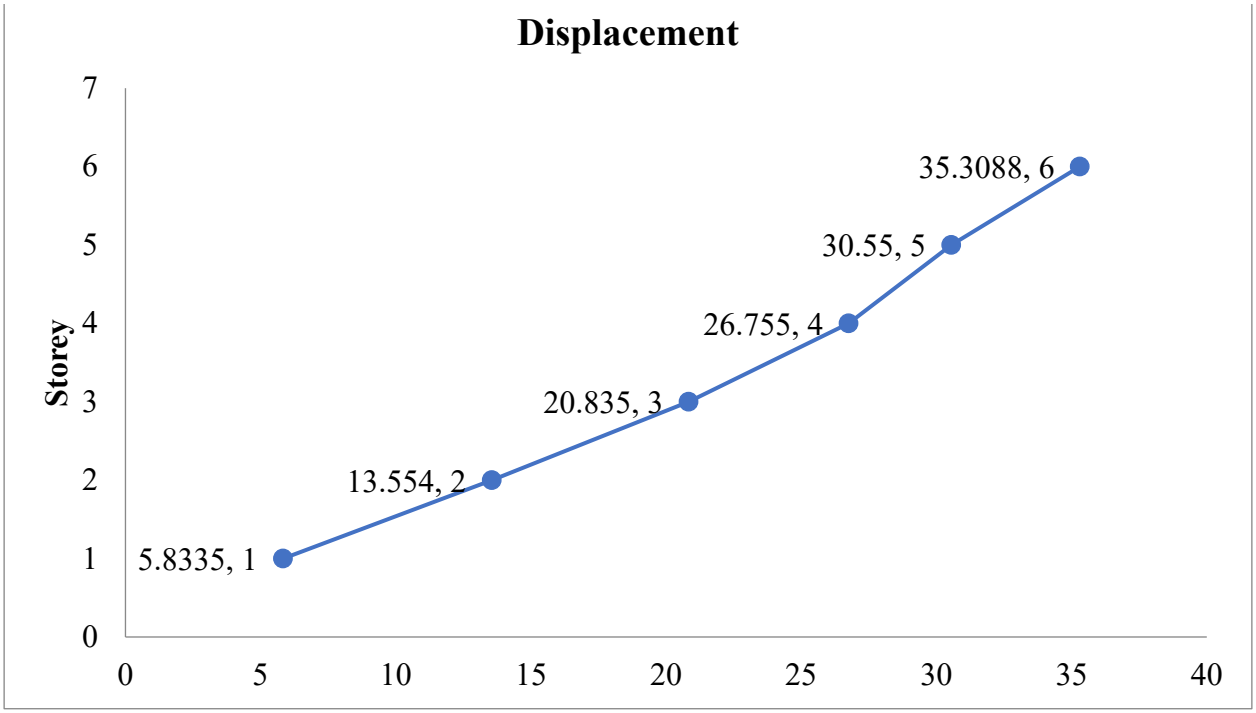

Figure 4: Displacement in X- Direction

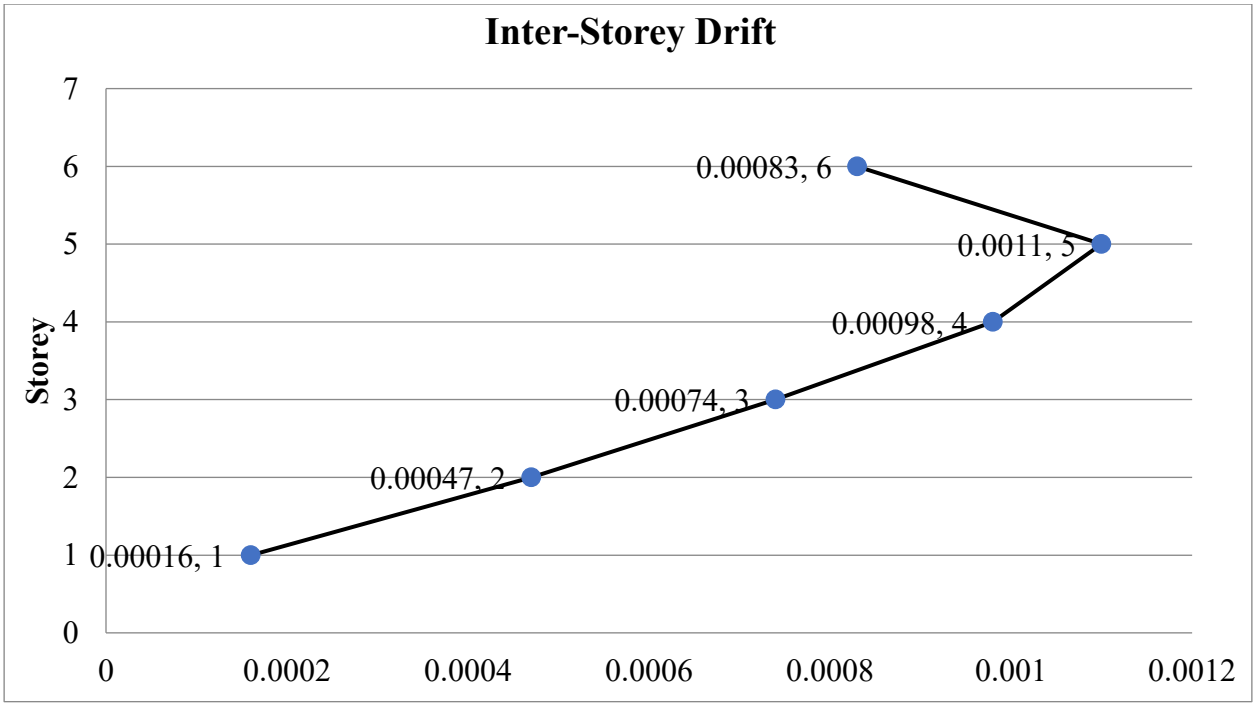

Figure 5: Inter Storey Drift in X- Direction

Torsion Calculation:

Torsion in general sense is the twisting or rotation effect, produced by the forces that cause the unequal movement of floor with in the same level. The major source of torsion is eccentricity and the initial attempts shall be made to minimize the eccentricity in the building. Eccentricity in the building can be minimized by:

i. Maintaining symmetry in buildings,
ii. Avoiding change in direction of forces within a frame,
iii. Not allowing to intersect the cantilever section, and
iv. Designing the structural members to withstand torsional forces/moments as per standard codes.

Provision shall be made in all buildings for increase in shear forces on the lateral force resisting elements resulting from twisting about the vertical axis of the building, arising due to eccentricity between the centre of mass and centre of resistance at the floor levels.

Table: 4 Torsion data in X and y direction

	EQX (U1)	EQY (U2)	Remarks
Storey-1	1.08	1.05	max. torsion of any storey shall not exceed 1.4
Storey-2	1.082	1.01	
Storey-3	1.11	1.004	
Storey-4	1.11	1.002	
Storey-5	1.11	1.004	
Storey-6	1.08	1.008	

Base Shear Calculation:

Base shear is the maximum lateral force that a structure's base experiences during an earthquake. It's calculated using the building's seismic zone, soil material, and building code lateral force equations.

Table: Base Shear based on IS 1895 Part 1

Storey	Weight (Wi)	Height(hi)	$Wihi^2$
5	2814.995	15	633373.875
4	2814.995	12	405359.28
3	2814.995	9	228014.595
2	2814.995	6	101339.82
1	2814.995	3	22401.18
	∑=13749		$\sum Wihi^2$=1390488.75

Determining base shear as per IS 1893:2016 part-1

$V_b = A_h * W$

$= (ZI*Sa*W)/(2R*g)$

$= 0.108*13749$

Therefore, V_b =1484.892 KN

5. Conclusion:

- The building design was done following the earthquake resistant criteria, ductile detailing and other essential codes.
- The resulting value of base shear obtained manually and from Sap analysis was found to be similar.
- The displacement value of our building was found to increase simultaneously with the increase in height of building.
- The maximum horizontal displacement of any floor was not found to exceed 1.4 times its minimum horizontal displacement at another end of same floor. Thus, the building was safe against twisting moment.
- The limiting value of storey drift of our building was 72mm which was not exceeded by any storey.
- Hence, the seismic analysis and design of our apartment building was found to be safe in every aspect of earthquake force and feasible for construction.

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INVESTIGATING DIGITAL SOLUTIONS FOR CIVIL ENGINEERING LABORATORIES: DEVELOPMENT AND IMPLEMENTATION OF THE 'EASY LAB' SYSTEM

Ashish Sapkota, Pawan Lamsal, Safal Shrestha, Sulav Baniya
Department of Computer Engineering, Pokhara Engineering College, Pokhara University
Corresponding email: erpawanlamsal@gmail.com

Abstract

Civil engineering laboratories in Nepal predominantly rely on traditional, paper-based methods for recording and analyzing test results, which are prone to human errors in calculations and graph plotting. These methods also entail significant costs for printing, storage, and hiring human resources for manual analysis. Furthermore, the lack of digitization makes data storage and backup challenging, posing risks to data accessibility and security. To address these issues, we propose **"Easy Lab"**, a web-based portal with integrated database functionalities. This system automates calculations, generates accurate analytical graphs, and ensures secure data backups, significantly reducing time, expenses, and errors. Despite the increasing availability of technology, even highly educated professionals in Nepal's civil engineering sector are reluctant to adopt digital tools. Our research identified key reasons for this hesitation:
Limited support from local development teams, making maintenance difficult.
The requirement for additional skilled manpower to operate existing systems.
"Easy Lab" aims to overcome these barriers by offering an intuitive, locally manageable solution tailored to the specific needs of engineering laboratories in Nepal.

Keywords: Soil Analysis, Civil Engineering Labs, Software for Civil Engineering Labs, JavaScript Implementations

1 Introduction

Even in this era of modern technology, labs for civil engineering tests are still using traditional paper-based observation files and graph as lab reports in our country Nepal. Even technical fields like labs are still lagging in the race of technological development. According to (National Population Census, 2021) 3% of total population of Nepal are engineers and according to (Surendra, 2018) more than 1000 new civil engineers are added every year. And all these engineers are performing thousands of tests every day.
Analyzing above stats, we have come up with an idea of **"Easy Lab"** and decided to digitalize problem solving approach by creating a web-based system with JavaScript, HTML and CSS that takes data from a portal and stores the data in SQL database.
On (pratikraut0000, Node.js MySQL Insert into Table, 2021) the author proposed a method to insert data from a web page to SQL database using NodeJS. And on (pratikraut0000, Node.js MySQL Select from Table, 2021) the author proposed a method to retrieve data from SQL database to NodeJS. We are planning to use these methods to help in our project.
From there we planned to connect the database to our report generation system which will show the graphical analytics of the test data that will drastically decrease the time spent to perform tests and to publish the result.
On (ChartJS, 2023) the author proposed a method to represent and analyze data using different charts using Chart in JavaScript.
The main focus of our research is to explore the exciting opportunities presented by web technologies by investigating their application in diverse application domains. In the first phase of the research, we plan to design a system that will perform sieve analysis, optimum moisture content test and maximum density test for any given soil sample, generate proper digital graphs analyze it and prepare a printable report that will also be stored in database as backup.

"Easy Lab" is system design especially aimed for civil engineering labs. We tried to develop it as efficiently as we could for the users. We performed a depth study on how OMC test, MDD test and Sieve analysis works and how traditional charts works as on analyzing the test results. We merged this concept and sculpted it. Through this study we sketched our easy-to-use user interface and designed a block structure through a proper requirement analysis. We consulted with our project supervisor for any problems and confusions we faced during development.

After this, we designed our project's webpage and implemented the frameworks required using RAD software development model. Then we interfaced all the required components to the website. After the completion of web interfacing, we worked on the report generation part to analyze and prepare final report from the data stored in SQL database and calculations done in NodeJS.

Then we worked on enhancing the UI/UX using CSS. All the testing and debugging procedures were performed by analyzing our project. By testing and debugging we were able to evaluate its accuracy.

We used Rapid Application Development (RAD) model of software development in this project. We divided the project into different modules and worked with individual modules. We divided our human resource into two groups of two people on each team. Each team worked on a module and at the end of the project, once all modules were ready, we worked for the integration of all modules which resulted in a working system for civil engineering labs to perform different soil analysis tests like OMC test, MDD test and Sieve Analysis of the sample and generate a proper report for all these tests.

2.1 OMC and MDD Tests

The Maximum Dry Density (MDD) test determines the maximum achievable density of a soil sample under specific compaction conditions. It is typically performed to assess the compaction characteristics of soil, which is crucial for designing foundations, roads, embankments, and other civil engineering structures.

The Optimum Moisture Content (OMC) test is performed in conjunction with the MDD test. It determines the moisture content at which the soil can be compacted to achieve its maximum dry density. OMC is a critical parameter as it helps engineers determine the ideal moisture content for compaction, ensuring the best possible compaction density.

2.1.1 Theory and formula

To find the OMC and MDD of any sample. The sample should be tested for multiple observations and we should determine the moisture content and dry density of each observation. The moisture content can be calculated as:

$$Moisture\ Content = \frac{wt.of\ water}{wt.of\ dry\ soil} \times 100\%$$

And the dry density can be calculated as:

$$Dry\ Density = \frac{100 \times \frac{wt.of\ wet\ soil}{wt.of\ container}}{100 + Moisture\ Content}$$

After multiple observations we can plot graph between the dry density (in Y-axis) and their corresponding moisture content (in X-axis). Then MDD can be obtained as the maximum value of the curve in Y-axis and the OMC can be obtained as the corresponding moisture content value of the MDD point in curve.

2.1.2 Calculations in Easy Lab

To perform these calculations easily and systematically Easy Lab utilizes the responsive and user-friendly UI given by ReactJS and secure server-side processing given by NodeJS. The system that we developed performs these tests as shown in following flowchart:

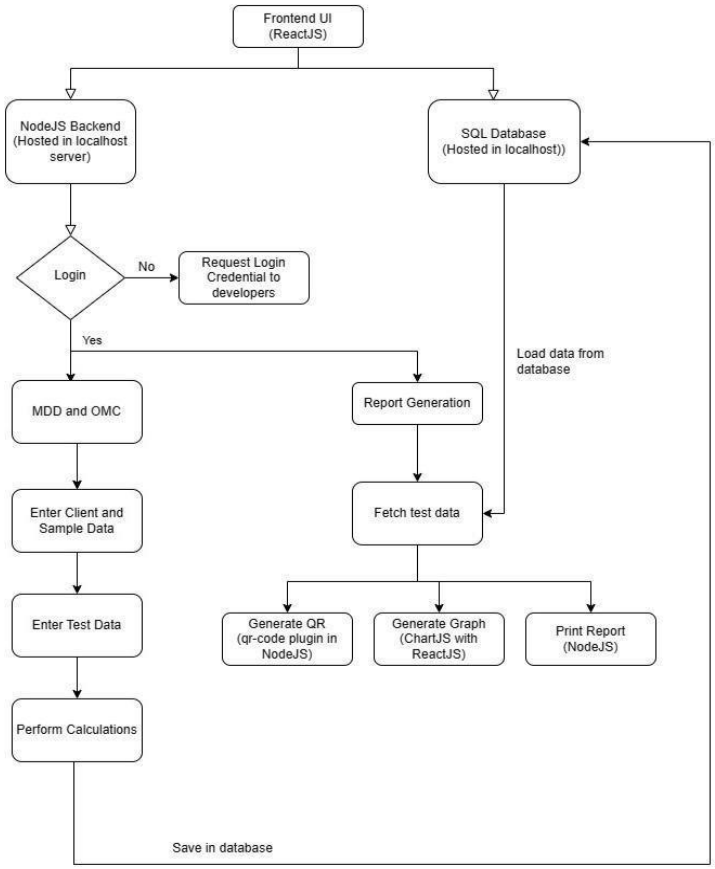


Figure 1: *Flowchart for OMC and MDD test*

As the flowchart explains the calculations are done in server-side with the data entered in the ReactJS frontend. The system asks client's data, sample's data and test data. Based on these data the moisture content and dry density for the sample is calculated and stored in database with a unique Sample ID which is autogenerated as a primary key in the database for test reports. Whenever a report is to be generated, the system retrieves test data from the database and prepares the report with unique sample id encoded in the QR code which 2-4 validates the authenticity of the report hence generated.

2.2 Sieve Analysis

Sieve analysis is a fundamental method in civil engineering and geology used to determine the particle size distribution of a granular material, such as soil, sand, gravel, crushed stone, or other aggregates. This information is critical in various construction, geotechnical, and materials testing applications.

The results of sieve analysis are typically presented in graphical form as a particle size distribution curve, also known as a gradation curve. This curve shows the percentage passing each sieve size on the vertical axis against the sieve size (in millimeters or micrometers) on the horizontal axis. Engineers use this information to classify the material and make informed decisions about its suitability for various engineering applications, such as concrete mix design, road construction, and filter design, among others.

2.2.1 Theory and Standards

Sieve analysis is done with the help of various standards giving the maximum and minimum standard passing percentage of various sieve sizes for different materials. The most common standards used in Nepalese engineering is given by (Indian Standard Specification for Coarse and Fine aggregates from natural sources for concrete (Second Revision), 1970) and commonly known as IS:383.

Theoretically, weight retained in sieves of different sizes are measured and their cumulative passing percentage is calculated. Now, curve is drawn between cumulative passing percentage (in percentage) and sieve size (in mm). This curve is compared to the standard curve. We have two standard curves, one with the maximum passing percentage and other with minimum passing percentage given by IS:383 standards. If the drawn curve remains in between these two standard curves, the analysis shows positive result.

2.2.2 Calculations in Easy Lab

Easy Lab uses (Indian Standard Specification for Coarse and Fine aggregates from natural sources for concrete (Second Revision), 1970) for sieve analysis. We searched any suitable API that we can call through our system to use this standard but there was no working API for such data retrieval so we created our own JSON file tabulating the data given by (Indian Standard Specification for Coarse and Fine aggregates from natural sources for concrete (Second Revision), 1970) for single sized coarse aggregate and graded coarse aggregate. With this JSON file created, we used ReactJS to create a data entry portal that calls this JSON file to select proper sieve size, maximum passing percentage and minimum passing percentage for the sample based on its type.

Once the data for every sieve size is entered and stored, we can generate curves using ChartJS. The overall process of Sieve Analysis can be discussed with the following flowchart:

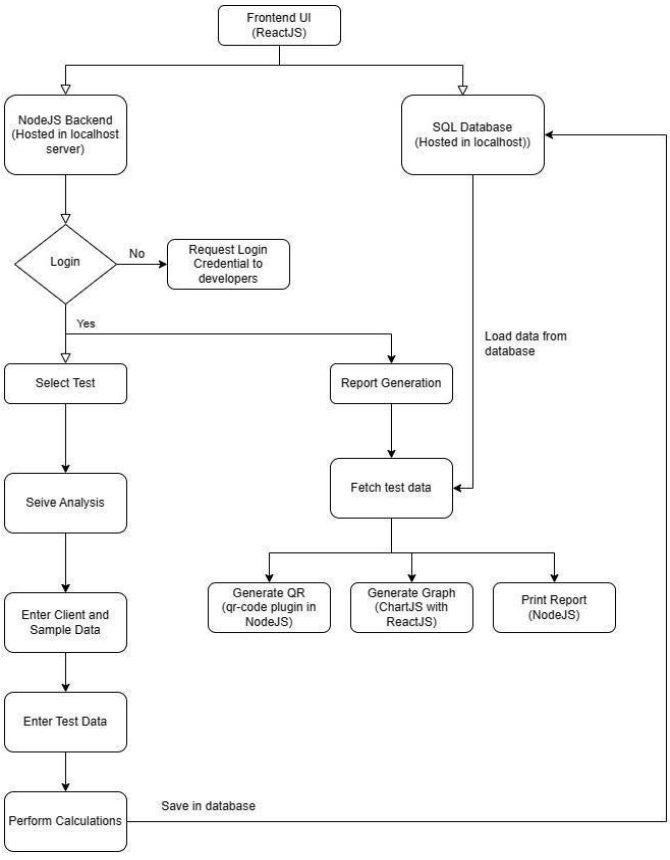


Figure 2: *Flowchart for Sieve Analysis*

In this way we developed a web-based system (Easy Lab) to perform OMC test, MDD test and Sieve Analysis for a sample. We believe it will be of great help to different labs and engineering field as well.

3 Results and Discussion

The result if the research was a developed system that can be used as a tool for Optimum Moisture Content (OMC) test, Maximum Dry Density (MDD) test and Sieve Analysis of a sample in civil engineering labs. The system is web based which means the initial setup cost is minimum as it can be hosted under the same domain as the lab's website. The system is always available even in the field visits as long as the user has internet connectivity and hence this system overcomes all the difficulties that most of the present software create allowing the use of technology in an efficient way.

3.1 Test Case and Result

The system has been tested with the following test cases:

Table 1: Test Case and Results

Test Case	Result
To test whether authenticated client is login or not	Pass
To test whether sample id is generated or not	Pass
To test whether data is saved in database or not	Pass
To test whether calculations are accurate or not	Pass
To test whether data is retrieved in backend or not	Pass
To test whether data is sent to frontend in proper format or not	Pass
To test whether graph is generated or not	Pass
To test whether a unique QR code is generated for each report or not	Pass
To test whether print function works or not	Pass
To test whether the created API for Sieve Analysis is working or not	Pass

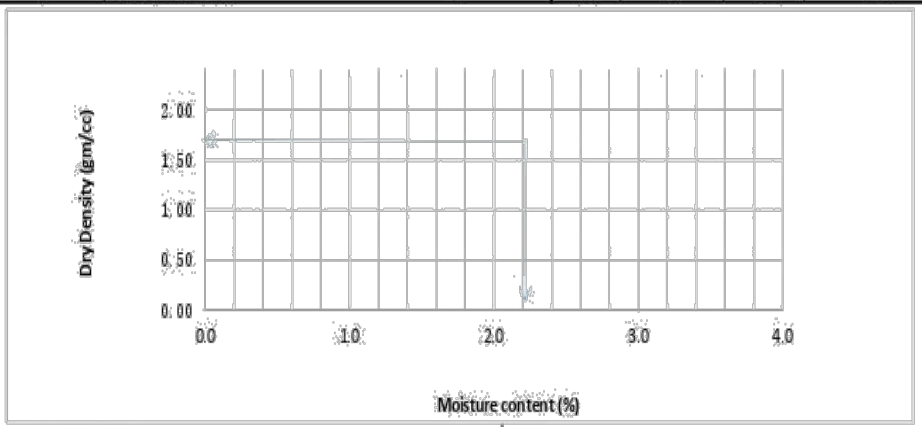
We determined all Pass state in the test cases for the developed system.

3.2 Comparison of Reports

3.2.1 OMC and MDD test

We did Optimum Moisture Content test and Maximum Dry Density test of a same sample by our system as well as the traditional method. The test equipment and sample were provided by Barahi Technical Solutions Pvt. Ltd., Pokhara and was performed under the guidance of senior engineers. The comparison of reports made by after the tests are:

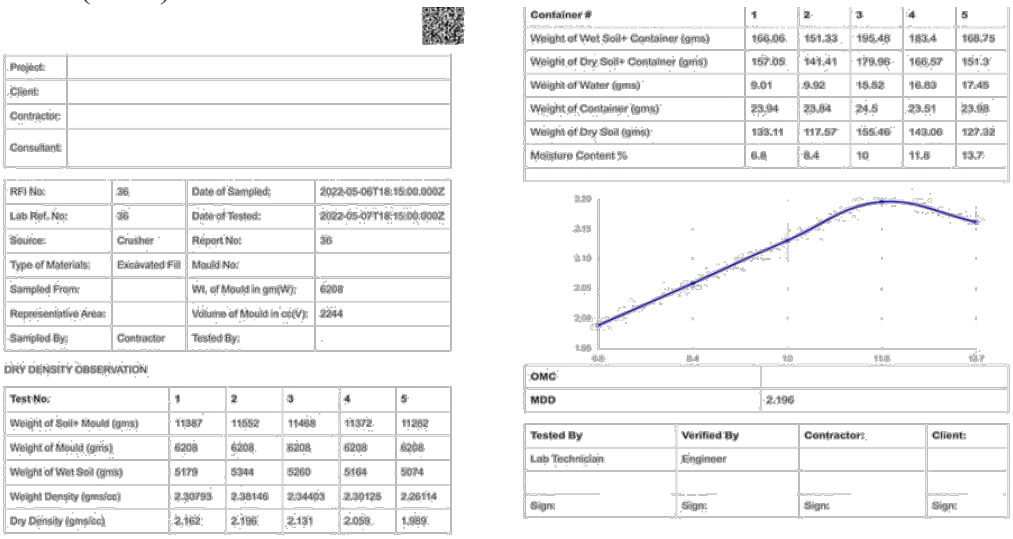
MOISTURE - DENSITY RELATIONSHIP (AS PER IS:2720 PART - 7 & 8)							
DRY DENSITY OBSERVATION							
Test No.			1	2	3	4	5
1	Weight of Soil + Mould	gms	11387	11552	11468	11372	11282
2	Weight of Mould	gms	6208	6208	6208	6208	6208
3	Weight of Wet Soil	gms	5179	5344	5260	5164	5074
4	Wet Density	gms/cc	2.308	2.381	2.344	2.301	2.261
5	Dry Density	gms/cc	2.162	2.196	2.131	2.059	1.989
MOISTURE CONTENT							
Container #			3	11	1	8	10
1	Wt. of Wet Soil + Container	gms	166.06	151.33	195.48	183.40	168.75
2	Wt. of Dry Soil + Container	gms	157.05	141.41	179.96	166.57	151.3
3	Wt. of Water	gms	9.01	9.92	15.52	16.83	17.45
4	Wt. of Container	gms	23.94	23.84	24.50	23.51	23.98
5	Wt. of Dry Soil	gms	133.11	117.57	155.46	143.06	127.32
6	Moisture Content	%	6.8	8.4	10.0	11.8	13.7



MDD (gm/cc) =1.94 OMC = %

Figure 3: *Traditional report for OMC and MDD test*

Form these two reports, we can see that the calculations made by Easy Lab for Optimum Moisture Content and Maximum Dry Density of the sample is on par with traditional calculations. The calculations are done with 3 digits after decimal and are accurately presented in a tabular form. Moreover, the graphical representation of the curve made between moisture content and dry density is clear and properly interpolated along the intervals in Easy Lab which is the advantage of implementing ChartJS technology in this test.



Project:	
Client:	
Contractor:	
Consultant:	

RFI No:	36	Date of Sampled:	2022-05-06T18:15:00.000Z
Lab Ref. No:	36	Date of Tested:	2022-05-07T18:15:00.000Z
Source:	Crusher	Report No:	36
Type of Materials:	Excavated Fill	Mould No:	
Sampled From:		Wt. of Mould in gm(W):	6208
Representative Area:		Volume of Mould in cc(V):	2244
Sampled By:	Contractor	Tested By:	

DRY DENSITY OBSERVATION

Test No:	1	2	3	4	5
Weight of Soil+ Mould (gms)	11387	11552	11468	11372	11282
Weight of Mould (gms)	6208	6208	6208	6208	6208
Weight of Wet Soil (gms)	5179	5344	5260	5164	5074
Weight Density (gms/cc)	2.30793	2.38146	2.34403	2.30125	2.26114
Dry Density (gms/cc)	2.162	2.196	2.131	2.058	1.989

Container #	1	2	3	4	5
Weight of Wet Soil+ Container (gms)	166.06	151.33	195.48	183.4	168.75
Weight of Dry Soil+ Container (gms)	157.05	141.41	179.96	166.57	151.3
Weight of Water (gms)	9.01	9.92	15.52	16.83	17.45
Weight of Container (gms)	23.94	23.84	24.5	23.51	23.98
Weight of Dry Soil (gms)	133.11	117.57	155.46	143.06	127.32
Moisture Content %	6.8	8.4	10	11.8	13.7

OMC	
MDD	2.196

Tested By	Verified By	Contractor:	Client:
Lab Technician	Engineer		
Sign:	Sign:	Sign:	Sign:

Figure 4: *Easy Lab's report of the same sample for OMC and MDD test*

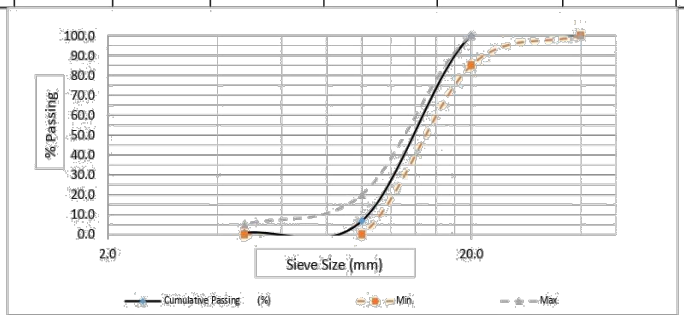
3.2.2 Sieve Analysis

We did Sieve Analysis of a same sample by our system as well as the traditional method. The test equipment and sample were provided by Barahi Technical Solutions Pvt. Ltd., Pokhara and was performed under the guidance of senior engineers. The comparison of reports made by after the tests are:

Grading of Coarse Aggregate (10.0 - 20.0) mm (AS PER IS 383)

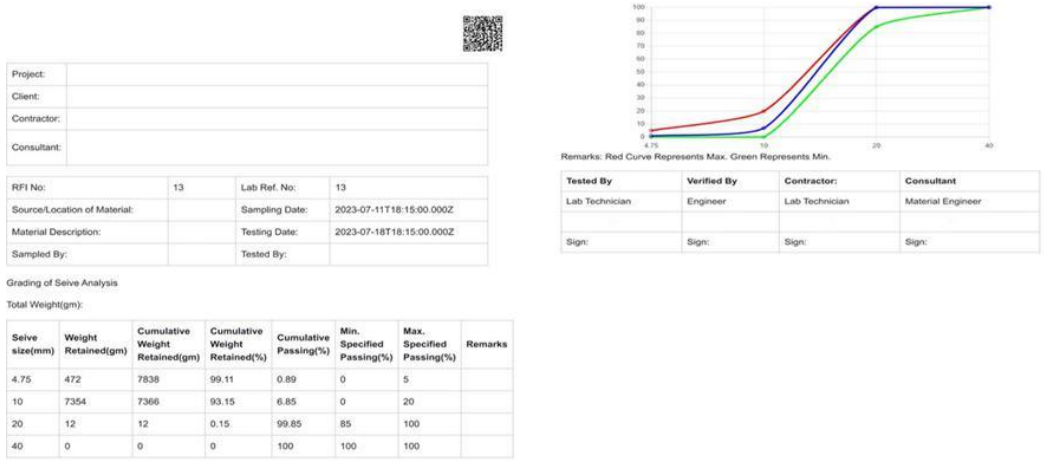
Total Weight (gm) : 7908.0

Sieve Size (mm)	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Weight Retained (%)	Cumulative Passing (%)	Specified Passing (%) IS 383		
					Min	Max	Remarks
40.0	0.0	0.0	0.0	100.0	100.0	100.0	
20.0	12.0	12.0	0.2	99.8	85.0	100.0	
10.0	7354.0	7366.0	93.1	6.9	0.0	20.0	
4.75	472.0	7838.0	99.1	0.9	0.0	5.0	
Pan	70.0						



Remarks:

Figure 5: *Traditional report of the same sample for Sieve Analysis*



Project:	
Client:	
Contractor:	
Consultant:	

RFI No:	13	Lab Ref. No:	13
Source/Location of Material:		Sampling Date:	2023-07-11T18:15:00.000Z
Material Description:		Testing Date:	2023-07-18T18:15:00.000Z
Sampled By:		Tested By:	

Grading of Seive Analysis

Total Weight(gm):

Seive size(mm)	Weight Retained(gm)	Cumulative Weight Retained(gm)	Cumulative Weight Retained(%)	Cumulative Passing(%)	Min. Specified Passing(%)	Max. Specified Passing(%)	Remarks
4.75	472	7838	99.11	0.89	0	5	
10	7354	7366	93.15	6.85	0	20	
20	12	12	0.15	99.85	85	100	
40	0	0	0	100	100	100	

Remarks: Red Curve Represents Max. Green Represents Min.

Tested By	Verified By	Contractor:	Consultant
Lab Technician	Engineer	Lab Technician	Material Engineer
Sign:	Sign:	Sign:	Sign:

Figure 6: *Easy Lab's report of the same sample for Sieve Analysis*

Form these two reports, we can see that the calculations made by Easy Lab for Sieve Analysis of the sample is on par with traditional calculations. The calculations are done with 3 digits after decimal and are accurately presented in a tabular form. The graphical representation of the curve made between different sieve sizes and corresponding cumulative passing percentage is clear and properly interpolated along the intervals in Easy Lab. Moreover, the graphical representation is easy to understand as the Maximum curve given by (Indian Standard Specification for Coarse and Fine aggregates from natural sources for concrete (Second Revision), 1970), Minimum curve given by (Indian Standard Specification for Coarse and Fine aggregates from natural sources for concrete (Second Revision), 1970) and the actual curve of the sample are all shown in a same canvas in different colours.

4 Conclusions

At the end of the research, we developed a proper web-based system as a tool for civil engineering. It is labeled as Easy Lab and it has properly met its objective of helping engineers perform various soil related tests with accuracy, generate authenticated reports and digitally backup such tests in database. To summarize our research, we found that engineering uses various tools and techniques to shape the world around us and if those tools are convenient and error free, the engineering practices would be easier and properly documented. We found that different computer-based software tools can be made to make engineering tasks error free and provide better analysis of tests. Such tools are very few in number and there is a vast room for software developers to show their talent in this field.

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JUVENILE CORRECTION CENTER

Pabina Acharya, Pradyumna Adhikari
Department of Architecture, Pokhara Engineering College, Pokhara University
Corresponding email: adhi.pradyumn27@gmail.com

Abstract

Juvenile correction centers play a crucial role in the rehabilitation and reintegration of young offenders, making them pivotal institutions in shaping the futures of these individuals and society's approach to juvenile justice. A comprehensive exploration of the evolving landscape of juvenile correction centers, with a particular focus on their development and impact within the context of Nepal. At its core, this research aims to untangle the complex interplay of factors influencing juvenile correction, encompassing the experiences of childhood and adolescence, the legal processes guiding these institutions, and the mechanisms employed for effective rehabilitation. The journey commences by delving into the historical transformation from punitive to rehabilitative strategies, witnessed in the United States and England, shedding light on significant milestones such as the establishment of juvenile courts and legislative reforms that have prioritized the welfare of young offenders. In addition to this broader narrative, we will delve into the unique challenges faced by South Asia, particularly Nepal, including issues related to safeguarding children's rights within the justice system and the escalating concerns surrounding juvenile delinquency. As we embark on this exploration, our aim is to offer valuable insights into the design, operation, and purpose of juvenile correction centers, addressing architects, planners, policymakers, and all stakeholders dedicated to fostering positive transformations in the lives of young offenders. Ultimately, the central objective of this research is to empower these young individuals and redefine juvenile correction centers as transformative platforms where reformation and reintegration into society take center stage.

Keywords: Defensible Space Theory, Juvenile Justice, Nepal, Rehabilitation

1. Introduction

Juvenile delinquency is a complex societal issue with far-reaching implications. It refers to unlawful behaviors committed by individuals who have not yet reached the age of adulthood, typically defined as 18 years old. The justice system has a specialized branch dedicated to addressing these offenses, known as the juvenile justice system, which aims to rehabilitate young offenders and redirect them towards more constructive paths. At the heart of this system lie Juvenile Correction Centers, institutions designed to house and rehabilitate juvenile delinquents. Juvenile delinquency encompasses a wide range of offenses committed by juveniles, from truancy to serious crimes. Various theories explain the causes of youth crime, including factors like adolescence instability,

family breakdown, socio-economic conditions, migration, modern lifestyles, poor education, violence at home and in the neighborhood, and peer pressure. juvenile delinquency is criminal behavior among young individuals, and the juvenile justice system aims to rehabilitate them. Correctional theories and facilities play a role in this process, addressing the complex causes of youth crime. Mainali, L. P. (2017).

1.1 History

In the 19th century, efforts to reform juvenile justice emerged in both the United States and England. The House of Refuge in New York City, founded in 1825, aimed to separate young offenders from adult criminals and provide them with care, education, and ethical values. Similar institutions, like the Chicago Reform School, followed suit. These early initiatives inspired the development of juvenile institutions in various states and abroad. By the late 19th century, the need for specialized legal procedures for juvenile offenders became evident. The concept of the juvenile court started to evolve, focusing on rehabilitation rather than punishment. Julia Clifford Lathrop established the first juvenile court in Chicago in 1899, emphasizing the fundamental rights of childhood and parental guidance.(Lawrence & Hemmens, 2008)

In England, a parallel movement recognized that unruly children were better rehabilitated through education and training than punitive measures. Reformatory schools and industrial schools emerged to address the needs of troubled children. The 1899 Paris Congress and the United States' adoption of the Elmira system highlighted the importance of specialized attention and individualized justice for young offenders. The Borstal System, introduced in England in 1902, further emphasized rehabilitation. (Lawrence & Hemmens, 2008)

In 1933, the Children and Young Persons Act replaced the 1908 Children Act in England, emphasizing the child's welfare and the importance of addressing their needs rather than punishing them. Overall, these historical developments marked a shift towards rehabilitative approaches in juvenile justice, recognizing that young offenders required special care and attention to reform and reintegrate them into society. (Lawrence & Hemmens, 2008)

2. South Asian Region

In South Asia, justice systems often mishandle children's cases within adult-focused frameworks, neglecting their rights and specific needs. Children who are victims of trafficking and exploitation can be treated as offenders and detained alongside them. Some countries in the region still allow the execution of child offenders, despite international standards against it. Additionally, setting low minimum ages of criminal responsibility, except in Afghanistan and Bhutan, falls short of global standards. In Nepal, while rural areas see minor delinquency like theft, urban centers face more severe issues such as sexual abuse, drug abuse, and prostitution among juveniles, particularly street children.

Juvenile detention centers have gradually shifted from punitive to rehabilitative approaches over the years. Singh, I.L. (1997)

3. Scenario in Nepal

Juvenile delinquency in Nepal has surged significantly, with 821 children sent to correction centers in 2018-19 compared to 380 in the previous fiscal year, marking a 115% increase. These centers, located in eight districts, house minors who commit crimes punishable by law. Bhaktapur received the highest number of juvenile delinquents (231), followed by Morang (138), Banke (109), and others. Most of the offenders (597) were aged 16-18 and were involved in various offenses, including rape, murder, drug smuggling, and theft. The trend shows a rise in criminal charges among juveniles in recent years. (Factsheet on COVID-19 and its effect on Juvenile Justice System in Nepal, 2020)

3.1 The Act Relating to Children, 2075(2018)

In 1992, Nepal introduced its first juvenile law, the Children's Act, which prioritizes the rights and welfare of children involved in the justice system. This law prohibits cruel or inhuman treatment of children and exempts those under 10 from punishment for offenses. For children between 10 and 14 who commit offenses punishable by fines, counseling is provided, while those committing offenses punishable by imprisonment may face up to six months in custody or placement in a child reform home for up to one year. Older juveniles aged 14-16 may receive half the punishment of adults for similar offenses, while those aged 16-18 may receive two-thirds of the adult penalty. Additionally, if a child in a reform home turns 18 before completing their term, they may be housed separately while considering their progress and education. Singh, I.L. (1997)

4. Literature Review

In the design of juvenile correction centers, several key principles must be prioritized, including rehabilitation, accessibility, and sustainability. These centers should feature well-thought-out layouts that encompass areas for intake, housing, education, recreation, vocational training, counseling, dining, and administration. Adequate facilities for toilets, urinals, showers, and medical examinations are essential. Different units within the center should be designed to cater to the specific needs of juvenile residents and staff, ensuring privacy and security where necessary. (Chusid, 1991)

Intake areas should offer processing facilities, showers, secure storage, and temporary holding rooms. Housing units must provide sufficient space, privacy, and essential amenities. Educational spaces should be equipped with classrooms and activity corners, while recreation areas should facilitate physical activity and social interaction. Properly equipped food service areas, well-ventilated laundry facilities, and accessible restroom facilities are crucial for the overall well-being of the occupants.

The design and layout of these facilities should prioritize the rehabilitation, safety, and welfare of young offenders. Functional components such as administration and public reception areas, conference spaces, libraries, staff zones, parking facilities, perimeter security measures, internal security zones, HVAC systems, MEP systems, technical rooms, and considerations related to architecture and psychology should all be carefully integrated into the design process. (Neufert Neufert, 2012). This comprehensive approach ensures that juvenile correction centers are not only secure but also conducive to the positive development and rehabilitation of their residents.

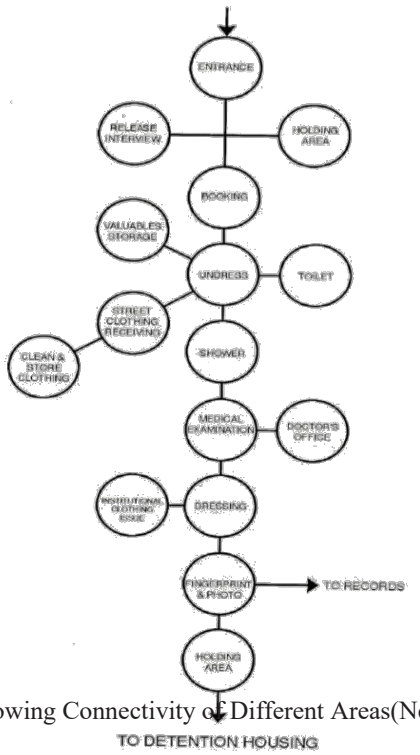

Figure 1. Flowchart Showing Connectivity of Different Areas(Neufert & Neufert, 2012).

5. Case Study

The national case studies in Nepal, featuring Bal Sudhar Griha in Sano Thimi and the Juvenile Correction Home in Sarangkot, highlight the struggle for child welfare and rehabilitation in correction homes. Bal Sudhar Griha, established in 1978 but formally running since 2001, faces overcrowding issues in its mission to provide child-focused care. Similarly, the Juvenile Correction Home in Sarangkot, established in 2012, also grapples with overcrowding, housing 88 juveniles despite a recommended capacity of 50. Both centers are managed by UCEP Nepal and emphasize child welfare and awareness. The regional case study of Pandit Jawaharlal Nehru Industrial School in Pune, Maharashtra, places a strong emphasis on creating a healing environment for juveniles by offering

vocational courses. In the international arena, the Department of Youth Services Detention Center in Westborough, Massachusetts, and Maasberg Juvenile Detention Center in Overloon, Netherlands, prioritize safe, transparent, and respectful environments for juvenile rehabilitation. The South Central Correctional Institution in Anchorage, Alaska, balances security with humane living conditions, and the Juvenile Probation Department and Lubbock County Youth Centre in Texas and the Roy McMurtry Youth Centre in Canada focus on creating home-like atmospheres to inspire rehabilitation and support for young offenders. These case studies collectively underscore the significance of nurturing and rehabilitative environments within juvenile detention centers.

6. Site Analysis

The selected reformation site, located 20 kilometers to the east of Pokhara City in Sath Muhane, offers an ideal setting for youth reformation. This semi-urban location, surrounded by lush landscapes, provides a tranquil and uncluttered environment for the healing process. Key advantages include the proximity to essential services such as workshops, schools, and a police station, ensuring educational and vocational opportunities, safety, and convenience. Access to the site is facilitated by a secondary road connected to the Prithivi Highway, and its south-north orientation maximizes sunlight while minimizing noise and traffic.

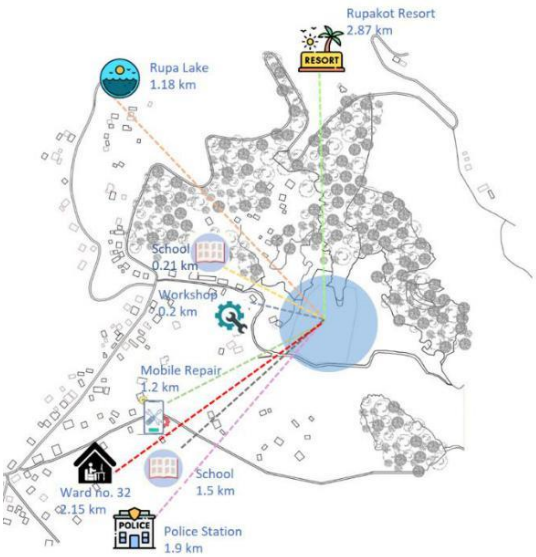

Figure 2. Project Location

A SWOT analysis reveals strengths such as its distance from the urban center, accessibility, and direct sun exposure, while weaknesses encompass the potential for farmland disruption and gravel roads. Opportunities include employment prospects and local access, with threats including potential settlement expansion and wildlife intrusion due to nearby forests. The site features a level topography, an elevation of 630 meters, and adequate infrastructure for water, electricity, and waste management. Its climate is classified as humid subtropical, with varying temperatures and annual precipitation. Socioculturally, it hosts diverse ethnic groups with limited communal activities, predominantly reliant on agriculture for their livelihood. Infrastructure elements comprise electric poles, a transmitter point, and a dependable water supply from Aabhukhola.

7. Design Development

The project primarily caters to children aged 10-18, with a total capacity for 80 students. It is the place where they get to learn how to interact and socialize along with the various life skills that will help them to reintegrate into the society.

7.1 Studying theory of Architect Oscar Newman

Defensible Space Theory is a concept developed by architect and urban planner Oscar Newman in the 1970s. The theory suggests that well-designed spaces can discourage criminal activity and promote social control by empowering residents to take ownership and responsibility for their surroundings.

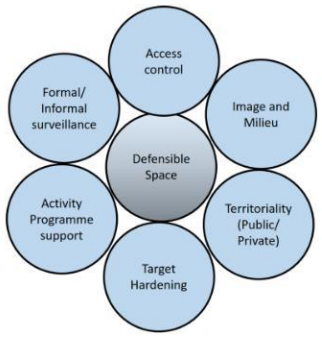

Figure 3. Defensible space

7.2 Making the Insignificant Significant

The concept of incorporating both significant and insignificant events in a child's life is important for their overall development. In juvenile homes, it is common for all activities to be contained within a singular block, which can make the environment feel disconnected from the outside world. Designing juvenile homes to mimic a city, with various journeys and exploration opportunities, we can provide a more realistic and enriching experience for these children. This approach allows them to start their day with a commute, just like children in the outside world, fostering a sense of normalcy and a connection to the broader community.

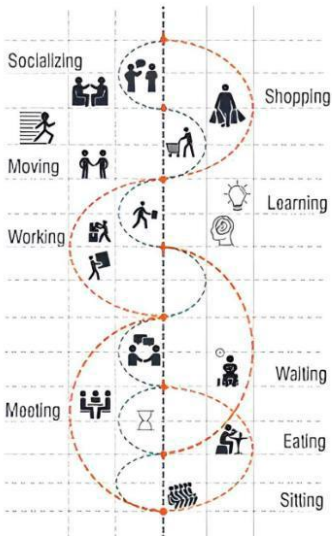

Figure 4. Activities

Incorporating a thoughtful concept into juvenile rehabilitation facility design entails recognizing the value of journeys between activities as opportunities for exploration and personal growth. The layout should encourage movement, curiosity, and discovery through interconnected zones dedicated to specific functions. Green spaces like gardens enable nature connection, while communal areas foster community and social interaction. Landscape elements enhance security without compromising openness. Understanding juveniles' psychological preferences for defined or open spaces is crucial. Careful separation of quiet and social areas ensures harmony. These principles prioritize security and young residents' well-being.

7.3 Masterplan Development

The facility's efficient rectangular design exudes stability and flexibility for future changes. Careful massing prevents problematic shadows. Linear planning results in discrete green pockets. The primary axis leads to the security check post, strategically positioned for controlled access. Semi-private functions like administration, classrooms, and dining balance accessibility and supervision. Private functions, including residential units, prioritize privacy and comfort.

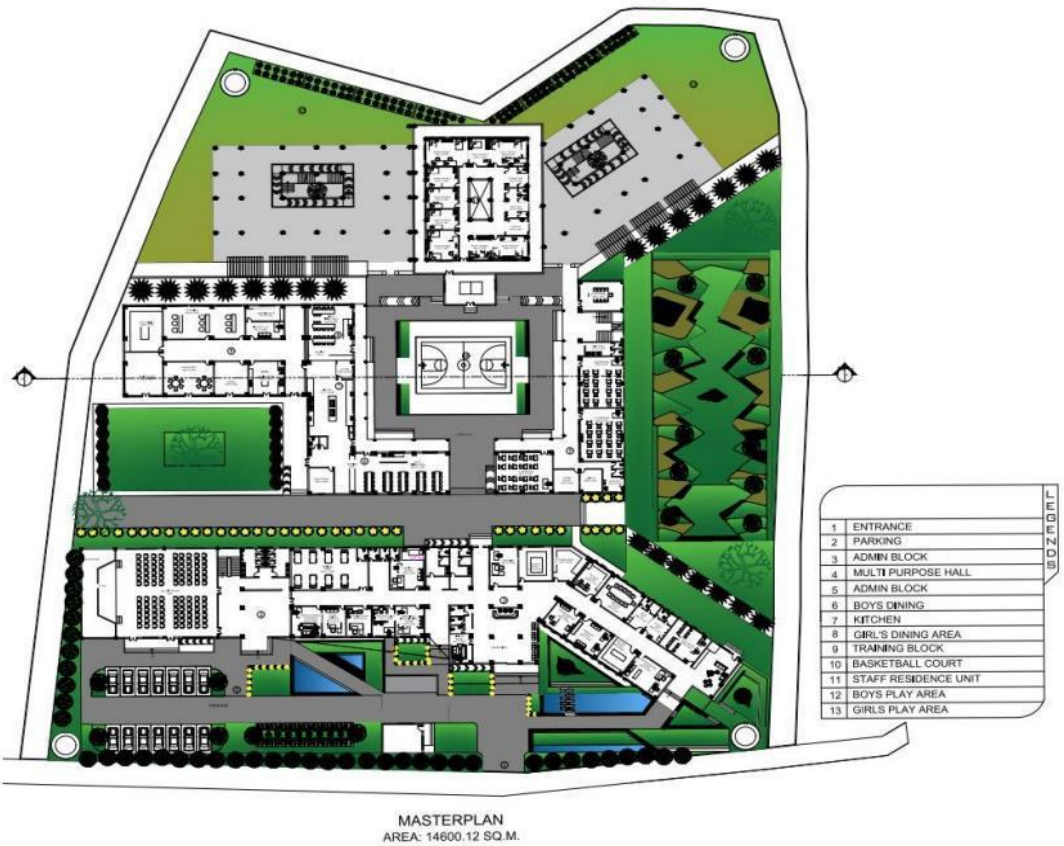

Figure 5. Masterplan

The entrance, administrative block, and vocational unit are strategically located. The kitchen and dining area ensures efficient meal service. A courtyard in the classroom block fosters an inviting learning space. Vocational units cater to various activities. The residential units, separate for girls and boys, ensure privacy and security. Open areas provide gender-segregated outdoor spaces for recreation. This master plan integrates solar path analysis, zoning, and linear planning for a well-organized juvenile correction center that emphasizes natural light and functional zones.

The administrative building serves as a secondary security boundary, housing the control unit responsible for safety and oversight. It includes staff areas, a reception, medical, and counseling offices. The control unit ensures controlled access and employs security measures for occupants and visitors. The school block features five classrooms, labs, and a library, fostering collaborative learning through a courtyard layout. The dining unit maintains gender-segregated serving areas for privacy and security during meals. The residential block prioritizes security and privacy for boys, girls, and staff. Recreational spaces on the ground floor encourage physical activity, social interaction, and creativity. The staff unit provides visibility and supervision of residents for enhanced safety and support.

8. 3d Images

Figure 6. Admin building

Figure 7. School and Dining Courtyard

Figure 7. Residential Unit

Figure 9. Interactive Space

Figure 10. Workshop (Plumbing)

Figure 11. Workshop (Electrical)

9. Conclusion

The meticulous design and operation of a juvenile correction center must uphold a core set of principles to effectively rehabilitate young offenders. The facility should be meticulously structured to prioritize simplicity, stability, and predictability, fostering an environment that nurtures a sense of security and belonging among its young residents. Achieving the delicate equilibrium in stimulus

levels is paramount, recognizing that excessive stimulation often underlies behavioral challenges within such institutions. Furthermore, the architectural layout should be carefully conceived to facilitate seamless transitions, ensure a clear and predictable spatial flow, incorporate effective visual cues and representations, and allocate dedicated safe spaces for emotional recalibration and security. These considerations are instrumental in empowering juvenile offenders to independently navigate the center while fostering their personal growth and development. Ultimately, a well-designed juvenile correction center can serve as a transformative catalyst, not merely as a place of punishment but as a platform for the reformation of young offenders. It offers them an opportunity to reintegrate into society as responsible and productive members, marking a critical step toward a brighter future. This research has endeavored to uncover the best practices and strategies for creating such an environment, one that stands as a beacon of positive change and rehabilitation for the youth it serves.

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ARCHITECTURAL INNOVATION AND COMMUNITY INTEGRATION: BUILDING THE FIRST CINEMA CENTER IN A CINEMA-FREE CITY

Sonisha Aryal, Manisha Shakya
Department of Architecture, Pokhara Engineering College, Pokhara University
Corresponding e-mail: aryalsonisha123@gmail.com

Abstract: This journal article presents a comprehensive investigation into the design and implementation of a Cinema Center in Waling City. This journal article presents a comprehensive investigation into the design and implementation of a Cinema Center in Waling City. The study explores the pivotal role of recreation and leisure in contemporary urban societies, emphasizing their status as the fourth pillar of human activity following agriculture, industry, and services. The article underscores the necessity for cinematic leisure to transcend conventional notions of recreation, sports, or hobbies, stressing the critical need for integrating recreation and leisure needs into urban planning, design, and management strategies.

1. Introduction, Theoretical Context, Scope and Methodology

This study delves into the urgent need for a Cinema Center in Waling City, where despite a substantial population, there's a stark absence of dedicated cinematic spaces, compelling residents to travel to nearby cities for movie experiences. Recognizing leisure and recreation as integral components of urban planning, the research underscores the demand for a new facility through a personalized survey, where 84.2% of respondents favored cinema over online streaming platforms. The proposed Cinema Center emerges as a vital solution, aiming not just to fulfill recreational needs but to serve as a cultural nexus, fostering social inclusion and artistic expression. The project's objectives revolve around providing an immersive cinematic experience, supporting local and national films, and enhancing community well-being. The research methodology involves a comprehensive analysis of urban fabrics, historical contexts, and technological advancements related to cinema centers, with data collected through participatory analysis and literature review. The design process emphasizes aesthetic appeal, functionality, and cultural relevance, integrating seamlessly with the cityscape while prioritizing sustainability and community engagement.

2. SITE

2.1 Site Zoning and Location Strategies for the Cinema center

Selecting the right location for a cinema hall is crucial for its success. Some site selection and location strategies to consider are:

- **Accessibility**: Choose a location that is easily accessible by public transportation or major roads. A cinema hall should be located in a busy area that attracts a lot of foot traffic.
- **Demographics**: Consider the demographics of the area, including age, income, and lifestyle. A cinema hall should be located in an area that is populated with the target audience.
- **Competition:** Analyze the competition in the area. Look for a location that is not already saturated with cinemas. Also, ensure that the competition is not too far away, as people may be reluctant to travel long distances to go to the movies.
- **Infrastructure**: Ensure that the location has proper infrastructure, such as adequate parking space, good ventilation, and proper security.
- **Visibility**: Choose a location that is highly visible and easy to find. This can be a busy street corner, a mall, or a major landmark.
- **Future development**: Look for a location that is poised for future development. A cinema hall should be located in an area that is growing and has potential for further expansion.

In summary, when selecting a site for a cinema hall, it's important to consider accessibility, demographics, competition, infrastructure, visibility, cost, and future development. By carefully considering these factors, you can choose a location that is best suited for your cinema hall and its audience.

Figure 1: Site location of Payal Cinemas, old Gurgaon

2.2 Project Location

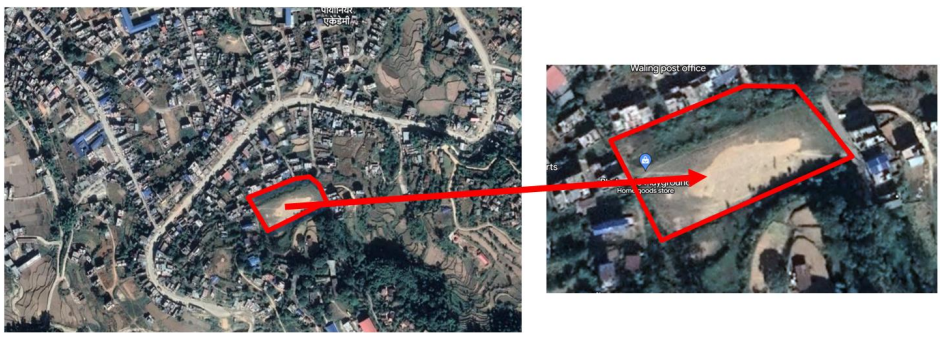


Figure 2: Location map of the site

The proposed site for the “Cinema Center” is located at Bhakunde, Waling-09- Syangja near Waling post office and police station. There are commercial centers like Sarjee Café, Adhikhola Auto parts, Hotel Venus etc. Currently site is used by the local kids and the students from the Punamrit Higher Secondary School as a playground. The site is a government land according to the zoning map of Waling Municipality.

Geographically, site has latitude of 27.58 degrees N and longitude of 83.45-degree E, the site has altitude of 771 meter above sea level.

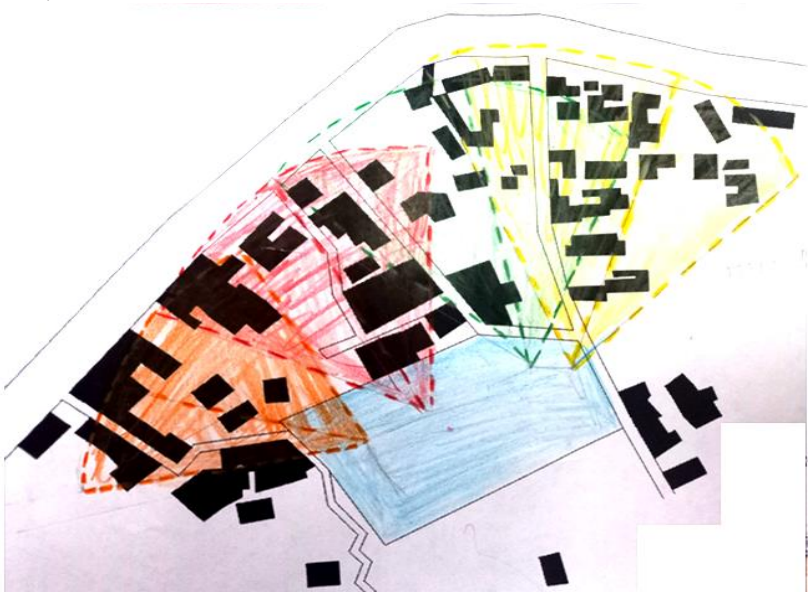


Figure 3: Influential area of the Hub

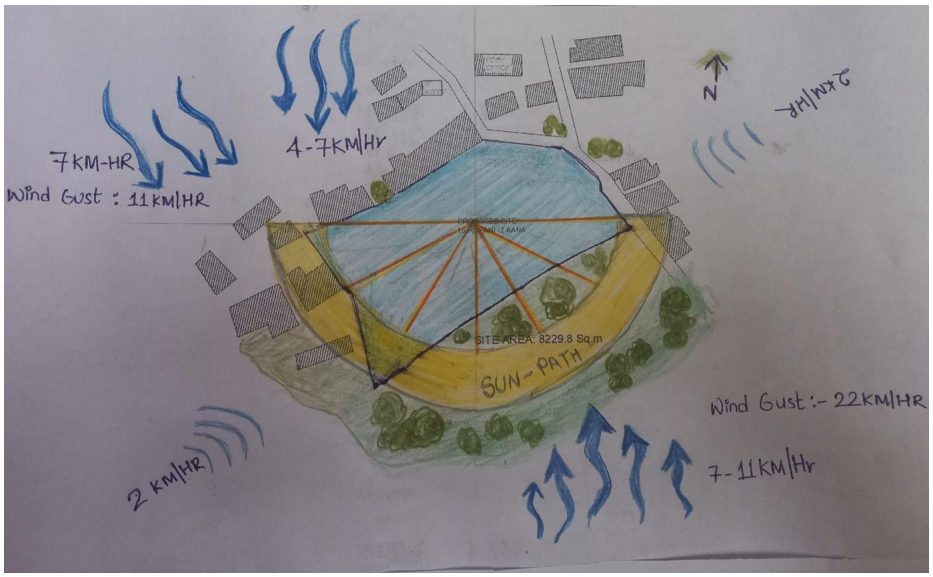


Figure 4: Sun and Wind Path

In crafting this architectural marvel, the site's elevation above the highway is leveraged to offer residents and visitors a captivating panoramic view of the city. Seamlessly integrating both pedestrian and vehicular pathways, the design harmoniously blends with the natural slope, creating elevated walkways and separate entry and exit points for vehicles, mitigating traffic challenges. Utilizing indigenous flora in the landscaping not only enhances the site's ecological sustainability but also provides natural sound barriers, creating a tranquil atmosphere. The building facades, strategically oriented along the major axes, incorporate solar control elements, such as louvers and balconies, ensuring energy efficiency and visual appeal. Beyond aesthetics, the complex becomes a hub of community engagement, boasting communal spaces, innovative smart technologies, and flexible living spaces. Embracing the region's cultural heritage, local art installations enrich the environment, fostering a sense of identity among residents. Through this meticulous blend of design innovation, environmental consciousness, and cultural integration, the project stands as a unique architectural landmark, setting new sandards for residential and commercial coexistence in the area.

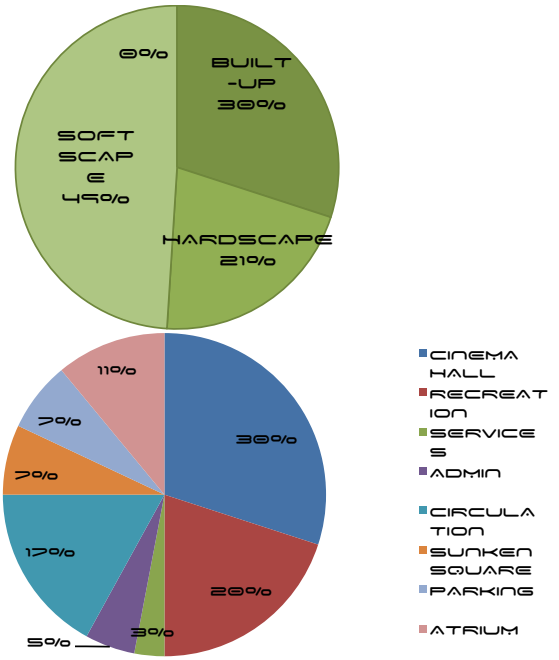


Figure 5: Area – Use

3. Design Concept Formulation and Design Approach

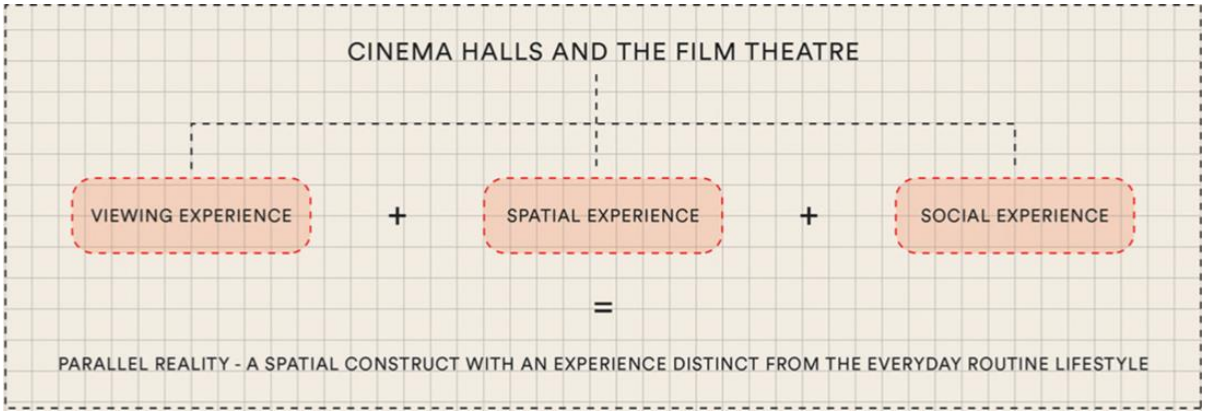
After going through various information collected from literature review, case studies and site analysis, design concept is developed. Site constraints and opportunities are considered while designing proposed building. The location, accessibility, topography, neighborhood context and many other things are responsible for the sustainability of proposed building in particular site.

As per conclusion, cinema hall is a commercial building and it requires site with high commercial valuing. Site is located in accessible location from any part of city as well as commercial plus residential zone with pedestrian movement. Proposed building is commercial as well as public building thus public comfort should be considered while designing the building.

3.1 Design Concept

Basic concept of the site is drawn with compatibility to the site and surroundings. With the maximum effort of architectural tool building concept is designed to attract remarkable mass with attractive building façade and planning.

Cinema center started off as creating a spatial experience for maximum engagement with the film. Over the years, with the rise in film culture, these spaces adapted and became social triggers of experience, identity and events.



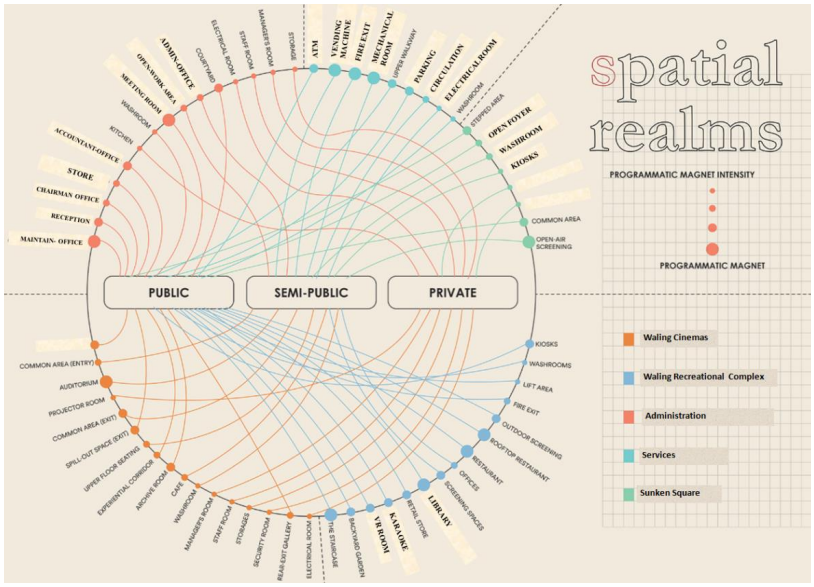
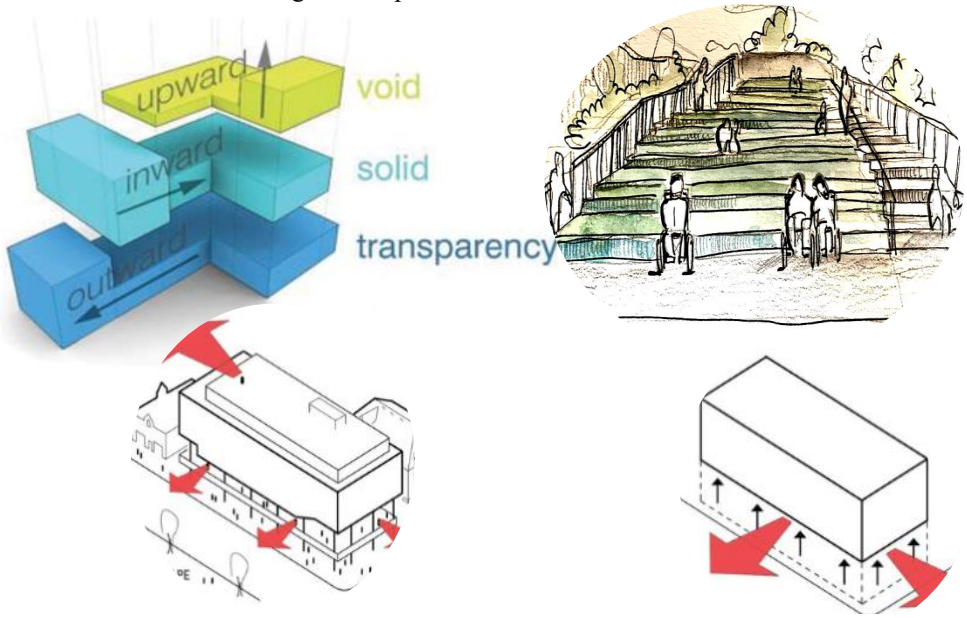


Figure 6 : Spatial Realms



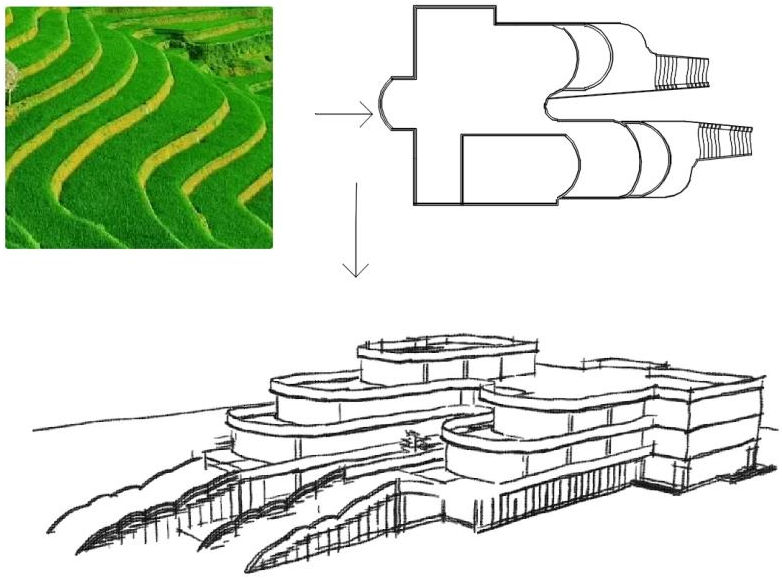


Figure 7: Shape concept formulation

The natural terrain of the site surrounding is in terrain form and the land enclosing the site is also steeped from the north to south although the site itself is cut into the plane land. So the building is planned to match it with the surrounding to give it a terrain look. Also the stepped air foyer at the front of the building enhances the terrain concept.

The building itself is an alloy of mass and void. The function evidently asks a balance fusion of mass and void. Transition of mass void is incorporated in both vertical and horizontal planning. The front portion of the building has the function asking the transparency. The void i.e. atrium open to the sky will provide light ventilation and also a social setting. The back portion of the building will house hall with solid mass for the acoustical purpose.

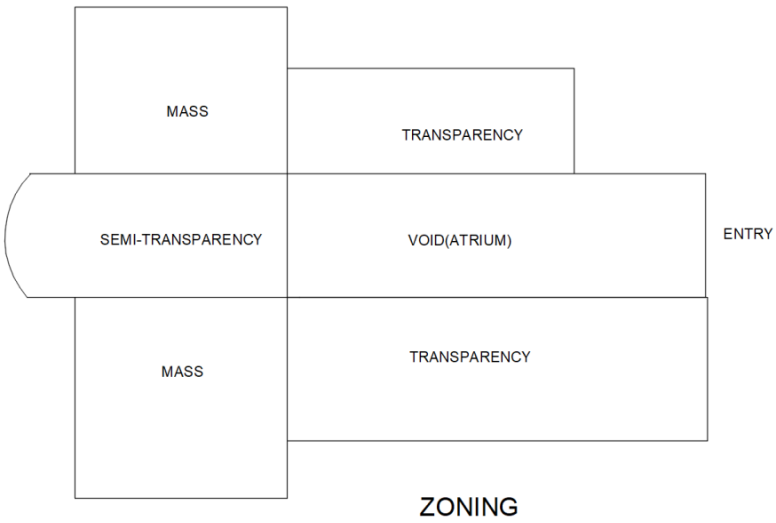


Figure 8: Mass and Void Concept Zoning

3.2 Zoning

The site is divided into several areas: main building, plaza, open foyer, parking, green space, and circulation paths. Visitor surface parking is situated in the southeast, with easy road access. The basement entry is also from the same direction. Separate entrances and exits are provided for service, pedestrian, and vehicle traffic. The building's entrance opens to the inviting plaza and open auditorium foyer, creating an elegant and welcoming atmosphere. The design emphasizes aesthetics, functionality, and green spaces, making it a distinguished architectural marvel. The service circulation doesn't intersect with the visitors. The stepped auditorium in the open plaza will be a green sitting space which will be stepped to 3.6m that is 1 floor height. Amenities for the wheelchair users will be maximized in the ground floor to minimize the circulation space. The plaza will also serve the space for kiosks and food courts to make it more engaging.

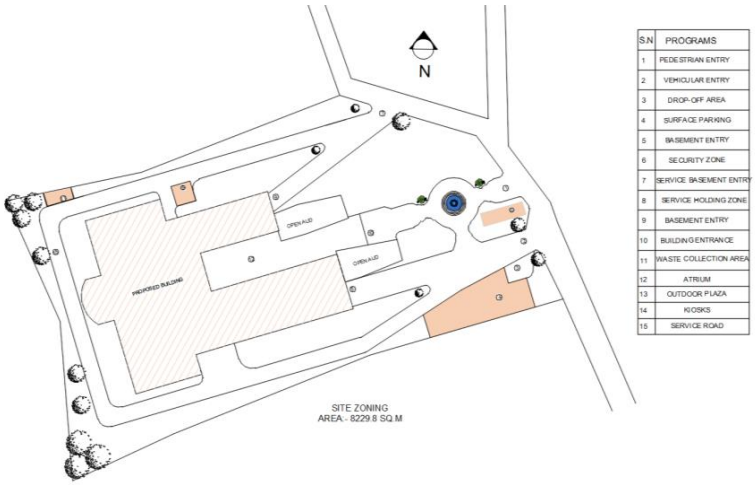


Figure 9: Site Zoning

3.3 Master Plan

The cinema center's design is strategically planned, with pedestrian access located along the central axis for convenience. The front portion is beautifully landscaped, creating a warm and inviting ambiance. The basement access is well-separated, catering to both service and visitor needs.

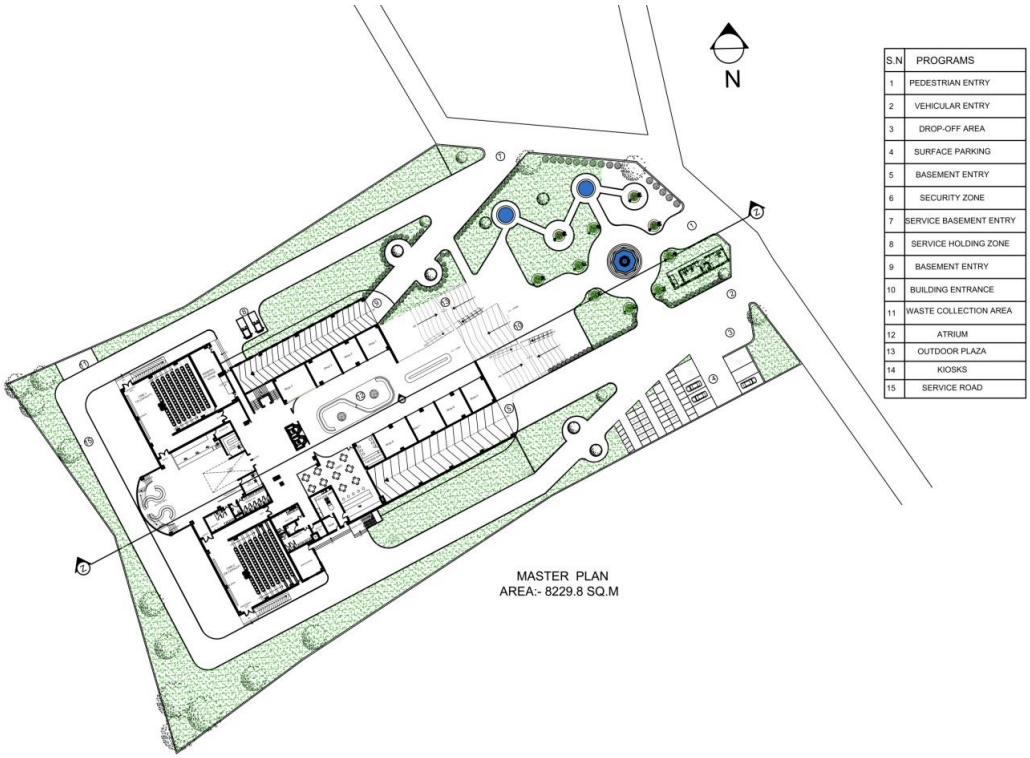
The surface parking area accommodates seven cars, including two spots for wheelchair users, and also provides space for 38 bikes, with two designated for wheelchair users. Additionally, seven bicycle stands are available for cyclists.

On the ground floor, two cinema halls, souvenir shops, an ATM booth, box office, restrooms, three lifts, one staircase, a food porto, and a café with outdoor green seating are thoughtfully arranged to cater to visitors' diverse needs.

The standout feature of the cinema center is the open auditorium located at the front of the building, adding vibrancy and serving as a social hub for various movie and music-related events and promotions. The curved terrace surrounding the front face adds a touch of drama to the design.

The kiosks adjacent to the auditorium will be covered with tensile stress material, enhancing the commercial appeal of the building.

For added convenience, a service road encircles the building, facilitating various operational requirements, including fire safety and emergency access.



S.N	PROGRAMS
1	PEDESTRIAN ENTRY
2	VEHICULAR ENTRY
3	DROP-OFF AREA
4	SURFACE PARKING
5	BASEMENT ENTRY
6	SECURITY ZONE
7	SERVICE BASEMENT ENTRY
8	SERVICE HOLDING ZONE
9	BASEMENT ENTRY
10	BUILDING ENTRANCE
11	WASTE COLLECTION AREA
12	ATRIUM
13	OUTDOOR PLAZA
14	KIOSKS
15	SERVICE ROAD

Figure 10: Master Plan

Landscape View

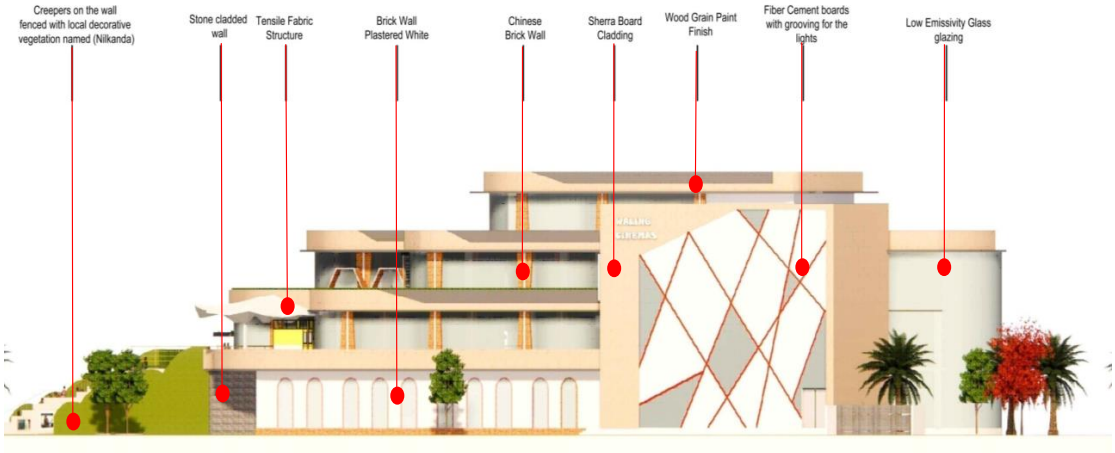
3.4 Form

The proposed building form takes inspiration from the natural shape of the site and the terrain concept, resulting in a design that optimizes the land usage while providing an inviting open recreational space in the front. The central hub has been thoughtfully designed to cater to both cinema hall visitors and passersby, offering amenities like cafes, souvenir shops, and food stalls near the entrances for their convenience.

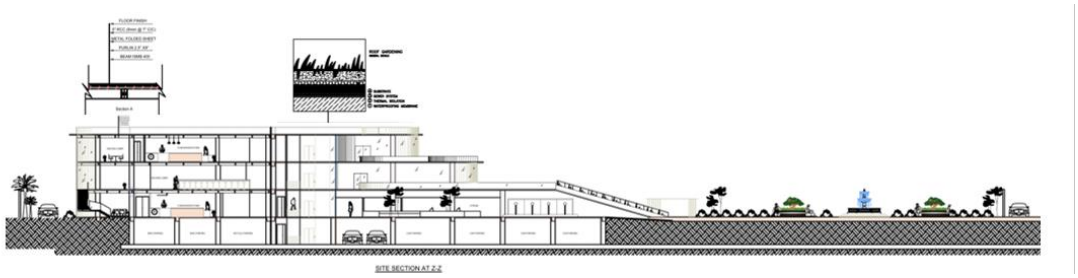
The focal point of the design is the central rectangular atrium, featuring water bodies and ample sitting spaces. This element creates a refreshing and relaxing environment, encouraging social interaction and enhancing the overall experience for visitors.

To ensure efficient circulation within the commercial building, the main hall is strategically placed at the back (west) portion, maximizing visitor flow. This arrangement helps in accommodating a higher number of visitors, contributing to the success of the establishment.

The addition of a curve in the front of the building serves a dual purpose. It not only adds visual interest and aesthetic appeal but also breaks the monotony of a continuous regular building form, creating a more dynamic and captivating facade.



Materials Details



3.5 Internal Planning

The proposed building is a combination of steel and RCC structure, providing a robust and efficient foundation. The grid size of 6m x 6.5m ensures a well-organized layout. The shops are strategically arranged around the central atrium, enhancing visitor flow and minimizing disorientation. To facilitate vertical circulation, two capsule lifts along the central axis and a staircase at the building's center length are incorporated.

Safety is a priority, and a separate fire escape route is designated in case of emergencies. Additionally, a service lift near the north side's service entry streamlines operational efficiency.

The basement level features ample parking space for cars, bikes, and scooters, along with dedicated areas for mechanical rooms and storage. Furthermore, provisions for parking two service vehicles and loading-unloading spaces are included.

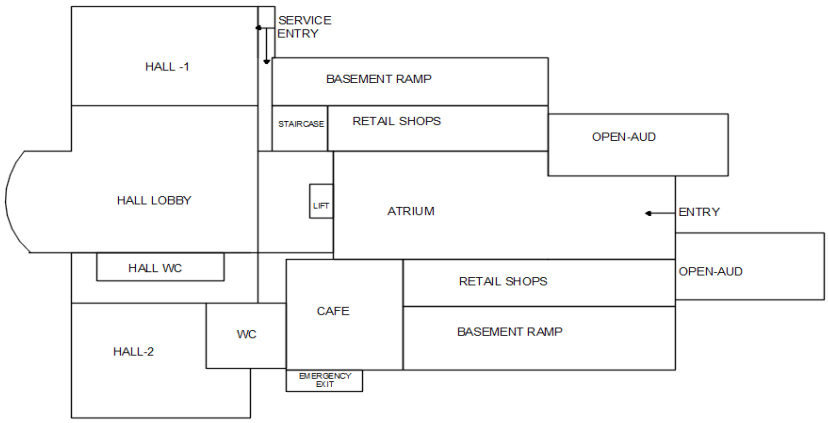
On the ground floor, retail shops, a food Porto, a café, and cinema hall lobbies with two halls offer a diverse range of amenities for visitors' enjoyment.

The first floor, accessible directly from outside as well, houses a VR station and a children's play area. The back portion continues the hall from the ground floor and features a waiting lobby with a bar space. Visual connectivity between the ground floor and the first floor's waiting lobby creates a seamless user experience.

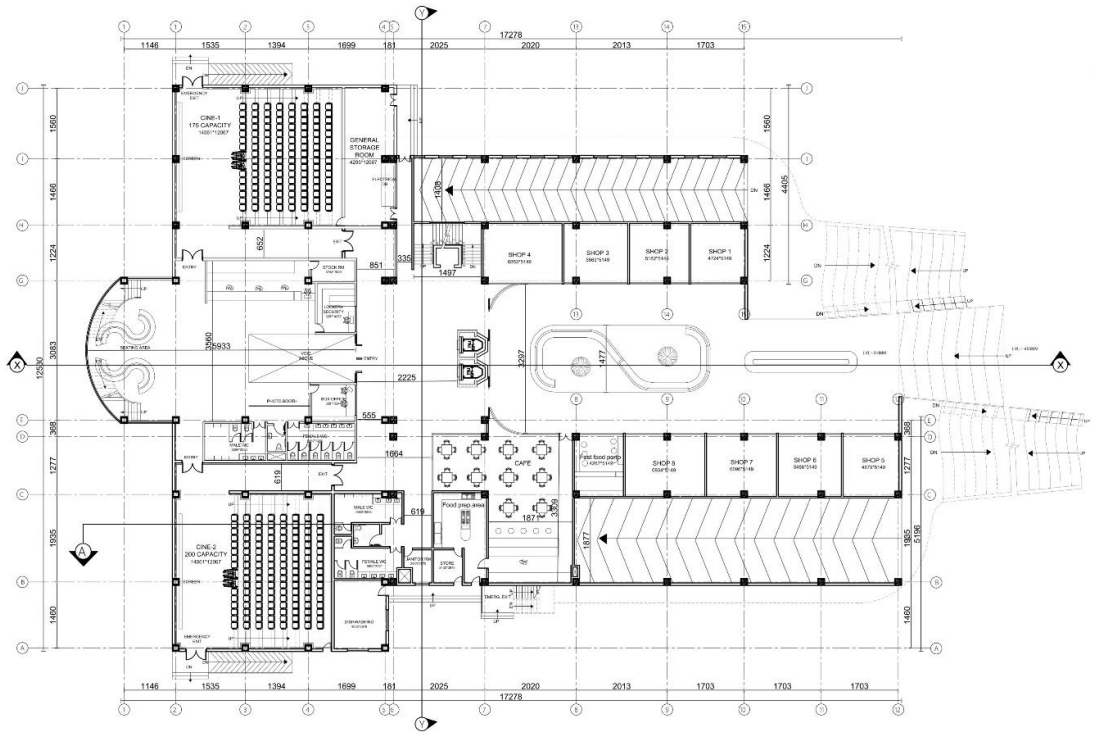
The third floor accommodates a library, a deluxe cine hall restaurant, and a dining space with outdoor screening. The stepped outdoor seating adds a casual and enjoyable atmosphere for screenings. The restaurant's design allows direct service from the kitchen area to the karaoke space behind it. The Deluxe cine hall, with a capacity of 50 persons, offers a unique and comfortable seating experience.

For administrative purposes, the fourth floor is accessed through a separate staircase for enhanced security. Electrical boxes are strategically placed, extending from the basement to each floor.

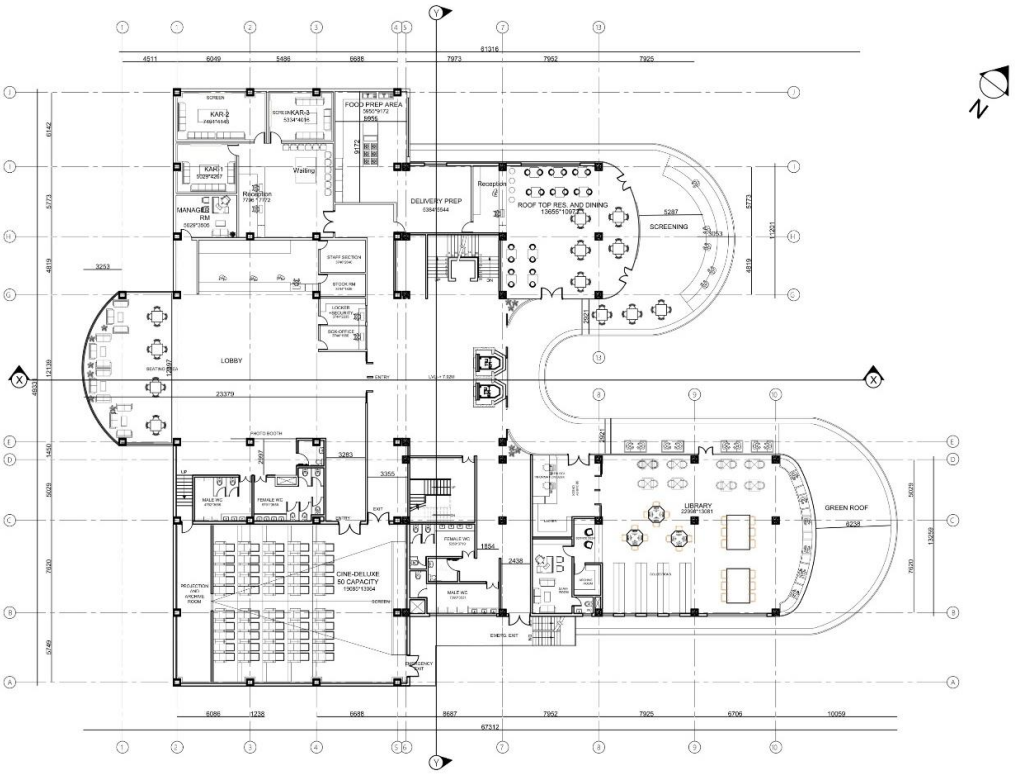
The building's thoughtful layout fosters a symbiotic relationship between its various functions, prioritizing visitor comfort while promoting commercial viability. The facilities are integrated to enhance the overall appeal of the cinema center, making it a vibrant and successful space for entertainment, leisure, and community engagement.



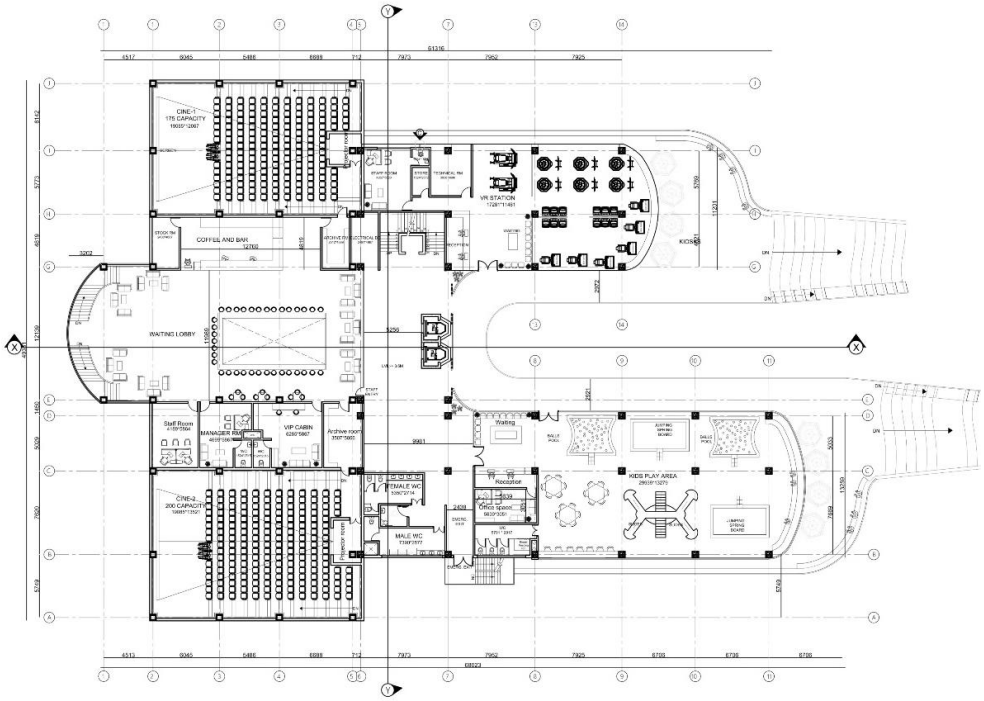
HORIZONTAL INTERNAL ZONING



GROUND FLOOR PLAN
AREA: 2916 SQ.M



SECOND FLOOR PLAN
AREA: 1779 SQ.M



FIRST FLOOR PLAN
AREA: 1979 SQ.M

Open Auditorium

Hall with wheelchair

Concession Stand

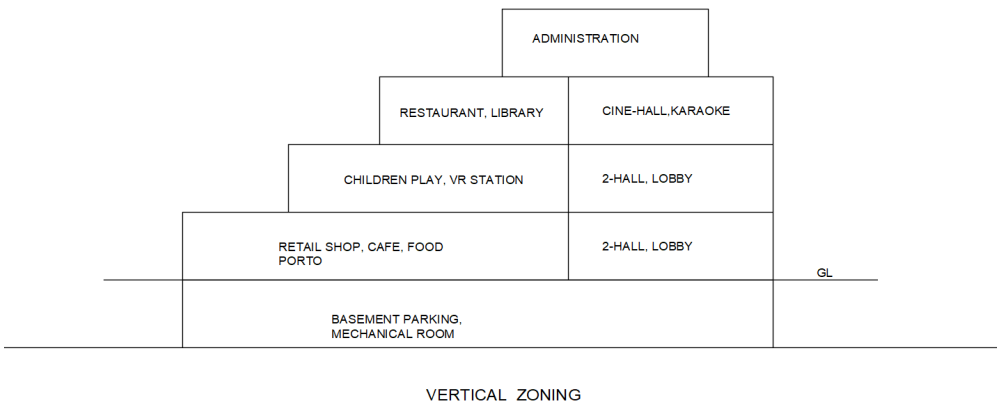


Figure 11: Internal Zoning

3.6 3D Concept

The building's form integrates the stepped terrain concept, resulting in a visually dynamic and engaging design. The incorporation of curves adds a touch of drama to enhance the building's aesthetic appeal. A green roof is introduced in the terrain portion, offsetting the built-up space and preserving green areas. Strategic use of a glazed façade around the commercial zone fosters visual connectivity with the external surroundings, creating a sense of openness and interaction. The front stepped foyer leading to the kiosks adds a remarkable element, elevating the overall ambiance of the space.

Emphasis is placed on the cinema hall block, as it serves as the primary focal point of the building. This design choice underscores the cinema center's main function, offering an immersive movie-going experience to visitors.

The strategic placement of the capsule lift grants a comprehensive view of the commercial zone, atrium, and the front landscaping. This positioning not only enhances the visitor experience but also provides a unique vantage point to appreciate the building's architectural features.

Figure 12: 3D view

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ARCHITECTURE IN HERITAGE HOTEL

Sneha Pahari, Pradyumna Adhikari
Department of Architecture, Pokhara Engineering College, Pokhara University
Corresponding e-mail: senazpahari@gmail.com

Abstract

Heritage hotels represent a unique intersection of history and hospitality in the face of rapid urbanization and globalization. These establishments breathe new life into historic buildings, preserving their architectural and cultural significance while catering to the contemporary traveler's needs. This thesis explores the multifaceted world of heritage hotels, delving into their historical context, the necessity of their preservation, and the implications of their existence in today's tourism industry. The heritage hotel industry is booming, with travelers increasingly seeking authentic experiences. However, this surge in popularity poses challenges to preserving historical integrity. Through a comprehensive analysis of case studies, this report highlights the importance of balancing conservation efforts with the needs of modern hospitality, tourism, and development. Furthermore, the journal evaluates the role of heritage hotels in promoting cultural significance and local economic growth and discusses the potential impact of future developments on these establishments.

Keywords: Heritage hotel, cultural significance, history, preservation

1 INTRODUCTION

Heritage defines as the cultural, historical, and natural resources that have been inherited from past generations are considered of great value to a particular society or community. This can include tangible heritage such as historical buildings, monuments, artifacts, and natural sites as well as intangible heritage such as traditions, language, folklore, and knowledge systems. It is often seen as a source of identity, pride, and continuity for a community and can be preserved and promoted throughout the ages with its significance.

The word hotel is derived from the French ***hôtel***, which refers to a French version of the townhouse. The term hotel was used for the first time by the fifth Duke of Devonshire to name a lodging property in London sometime in AD 1760. Historically, in the United Kingdom, Ireland, and several other countries, a townhouse was the residence of a peer or an aristocrat in the capital of major cities. The word hotel could have also derived from the ***hostel*****,** which means '**a place to stay for travelers '.** According to WTO, a hotel is "an establishment that provides accommodation, meals, and other services for travelers and tourists,

usually for a fee". A heritage hotel, which fall under the category of hotel based on theme, is an exquisite and sophisticated establishment that honors the cultural heritage and rich history of a region, providing guests with an immersive experience that captures the essence of local traditions. These hotels are usually located in a historical building that has been restored to its former glory and features opulent architecture, period furnishings, and authentic decor, which create a sense of being transported to a bygone era. Heritage hotels also tend to offer the sense of exclusivity, luxury, and sophistication, catering to the discerning travelers who are in seek of the most authentic experience. The ambience and the atmosphere of a heritage hotel evoke a sense of nostalgia, with indulgence of the guests in the cultural essence, while enjoying modern amenities and world-class hospitality.

1.1 HISTORY

1.1.1 International

The concept of heritage hotels has existed for a long time, particularly in Europe where chains such as Relasis & Châteaux, Small Luxury Hotels, and Paradores link historic and exquisite properties into hotel chains. These hotels are usually visited by couples, families, and small groups of friends rather than large groups of tourists, as the historic buildings were not originally intended for hospitality on a large scale. They mostly cater to Special Interest tourism. After India gained independence in 1947, over 500 ruling princes combined their lands to join the former British territories and form the new democratic nation of India. However, the relationship between the royalty and the Indian government began to change. The rulers who had allied closely with the British were often seen by nationalists as puppets of foreign rulers and were marginalized. In 1950, the Jagirdari system was abolished, and the erstwhile rulers and nobles had to learn to earn a living. In 1970, the privy purses were discontinued, and the titles of the rulers were abolished by law, making them common Indian citizens.

As a result, many forts, royal palaces, shikar badis, water palaces, mountain retreats, and beach houses began to be neglected and fell into disrepair. Many of the former rulers found it difficult to let go of these properties and were more concerned with holding onto them as a matter of pride than thinking constructively about what to do with them.

The trend of converting these historic buildings into heritage hotels began in India when Maharaja Man Singh II of Jaipur first considered shifting from the sprawling Rambagh Palace to a smaller one previously lived in by the British Resident. Despite facing opposition, on December 8, 1957, the Ram Bagh Palace Hotel was formally opened, and the Maharaja of Jaipur became the first active princely hotelier in India, setting a trend that continues to this day.

1.1.2 National

Nepal is known for its rich cultural heritage, and visitors can experience this history firsthand by staying in one of the country's many heritage hotels. These hotels have a long history in Nepal, dating back to the early 20th century when the country first opened to foreign visitors. At the turn of the 20th century, numerous historic buildings in Nepal, such as palaces and residences of the aristocracy, were becoming unused and neglected. As a result, there was a rising interest in preserving these buildings for future generations, leading to the birth of heritage hotels in Nepal.

The Yak and Yeti Hotel, situated in Kathmandu, is one of the earliest heritage hotels in Nepal. The palace was originally constructed as a neo-classical private residence in 1910 by the former Prime Minister of Nepal, Bir Shamsher Jung Bahadur Rana. It combines traditional Nepalese architecture with European influences and is named after two legendary figures in the country's history - the Yeti and Yak. Yeti is a mythical creature believed to inhabit the Himalayan region whereas Yak is a large domesticated wild ox in Himalayan region as well. The building was originally constructed for the rana family, who ruled over the century, as a private residence. Following years of disuse, the palace was acquired by a group of investors in the 1960s and underwent extensive renovations to convert it into a luxury hotel. In 1977, the Yak and Yeti Hotel was opened to guests and has since become a popular destination for tourists and dignitaries worldwide.

1.2 Types of Heritage hotel

1.2.1 Heritage grand

According to HRACC (Hotel and restaurant approval and classification committee), heritage grands are those which are built prior to 1920AD with minimum of 15 rooms (30 beds). The overall concept of a heritage hotel should be reflected in its features and ambiance, with a focus on preserving the building's architectural distinctiveness. It is important that all areas, including private and public spaces, have a superior appearance and decor. Heritage grand is considered to give the authentic as well as luxurious experience to the guest. It seeks to provide luxury in context to the modern architecture without having to disrupt the original classic heritage.

1.2.2 Heritage Classic

According to HRACC (Hotel and restaurant approval and classification committee), heritage classics are those which are built prior to 1935AD with minimum of 15 rooms (30 beds). Heritage classics gravitate more towards the authentic experience and classic culture of the certain place. It does not believe in the modern take in its design and style. Although it mentions the basic facilities to be fulfilled in heritage hotel but cannot be compared to the luxury of the heritage grand.

2 Kaskikot

Kaskikot is a quaint hamlet nestled in the Kaski district of Pokhara, Nepal. The distance from Pokhara main city to Kaskikot is approximately about 17kilometers. Its perch atop a hill affords visitors breathtaking vistas of the majestic Himalayan mountains, notably the Annapurna range. The village is renowned for its pristine natural allure and its wealth of cultural traditions and customs. The Kaskikot hilltop is one of them. Kaski is the name of the place and 'kot' means 'fort' in the Nepali language. About the derivation of the name 'Kaski' there are two versions. According to one version, 'Kaski' is the name of a costume which is worn by Tamu (Gurung) indigenous people, from the waist to the knee, now known as 'kacchad' by distortion. It is associated with a petty king or chieftain who belonged to Tamu aborigine at the start of the settlement in Kaski. This gives the historical fact or source of the name Kaski. Another version is from a Hindu legend or fiction. According to the fiction, a sage called Kashyap had meditated in that place. So, the name Kaski is given to this hilltop (Subedi 2004, p 27). There is a saying 'Ghale Mari Shahi Rajaya' still in the tongue of the local people, which means killing Ghale (We) chose Shahi (Shaha). This is the political and historical information about the Kaskikot hilltop (ibid). By the name of Kaskikot, the whole place is named with the word Kaski (Niraula 1986).

2.1 History and evolution:

West Nepal was divided into 24 small principalities prior to the unification of Nepal, and Kaski was one among them. Kaski is the ancestral state of the Shaha kings of Nepal whose capital was Kaskikot about 1650 years ago. Kaskikot's earliest recorded history can be traced back to the 16th century when it was founded by the Khas Rajas, a group of warrior kings. The warrior kings were renowned for their military prowess and hence established the Kasikot strategic locations for their military operations. By the 18th century, the Khas Rajas had been conquered by the Gurkhas, who went on to rule the region for many years. The Gurkha King Prithvi Narayan Shah launched a campaign to unify the various kingdoms under his rule. Kaskikot was one of the last kingdoms to surrender to his forces, and it was a key strategic location due to its position on a hill which overlooks the surrounding countryside. In the early years of the Shah dynasty, Kaskikot played a significant role as an administrative center and a thriving hub for trade and commerce. The village was particularly renowned for its skilled artisans who produced exquisite handicrafts, including beautiful textiles and pottery. During the mid-20th century, Kaskikot experienced a notable transformation with the construction of a road that linked it to the city of Pokhara. This new transportation infrastructure paved the way for fresh prospects in trade and commerce. Additionally, the road brought an influx of tourists who were captivated by the village's breathtaking natural scenery and rich cultural heritage.

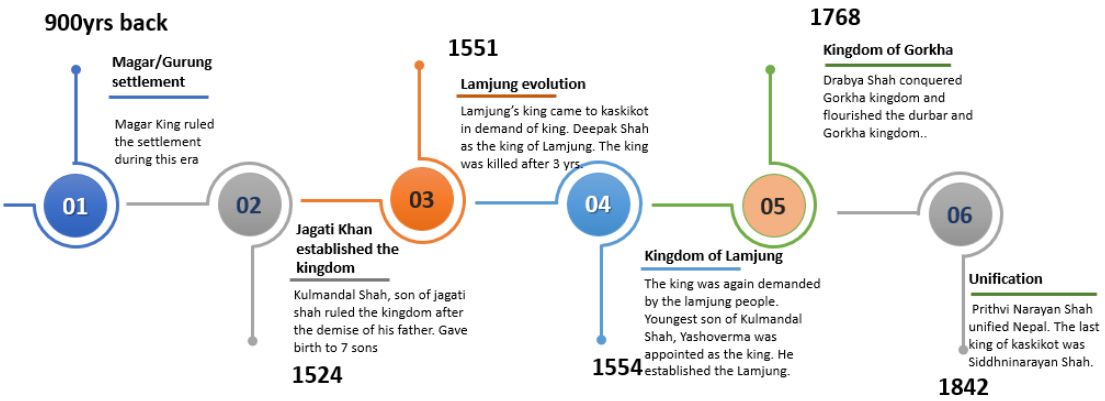

Figure 2-1 Historical timeline

2.2 Settlement

Kaskikot is a clustered settlement, where the houses and buildings are in close proximity to each other, creating a tightly packed and densely populated community. The houses are often built in a way that shares common walls, with narrow alleys and streets meandering through the village. This clustering of houses is a common feature of traditional villages in Nepal and is particularly common in hilltop settlements where the available space is limited. At the time of the 1991 Nepal census, Kaskikot had a population of 6,075 people residing in 1,185 individual households. According to the census of 2011, the population has decreased to 5,892 people residing in 1,508 households.

2.3 Evolution of Architecture

The architecture of Kaskikot is of typical traditional Nepalese hilltop settlements. The houses are generally made of locally sourced materials such as stone, mud and wood. Corrugated iron is commonly used as roofing material for houses in Kaskikot, but in the past, thatch or wooden shingles were the preferred roofing materials. This change in roofing materials reflects the modernization and industrialization of the village, which has led to the adoption of new construction technologies and materials. However, traditional roofing materials such as thatch and wooden shingles are still used in some parts of the village and are an important part of Kaskikot's architectural heritage.

3 Project Location:

The site is located on Bansthale, Kaskikot- Pokhara near the paragliding take off point. It holds the historical significance as Kashyap rishi meditated in the hill of bansthale. It lies at an altitude of 1750 above sea level. This extraordinary location unfolds a panorama of captivating vistas along each cardinal axis. To the north, it is graced by the awe-inspiring presence of the Machhapuchre range, a majestic spectacle that enchants the beholder. On the western axis, the ancient Kaskikot palace stands as a testament to history, casting a regal shadow on the landscape. In the south, the encompassing view extends to the tranquil beauty of the lake, while the eastern axis unveils a breathtaking sunrise.

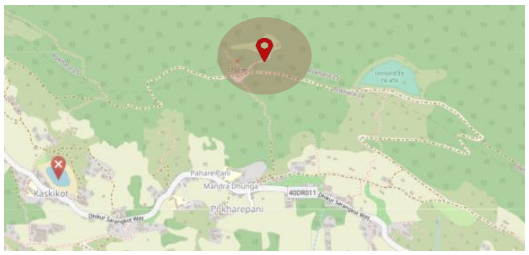

Figure 3-1 Site location map

3.1 Site Proximity

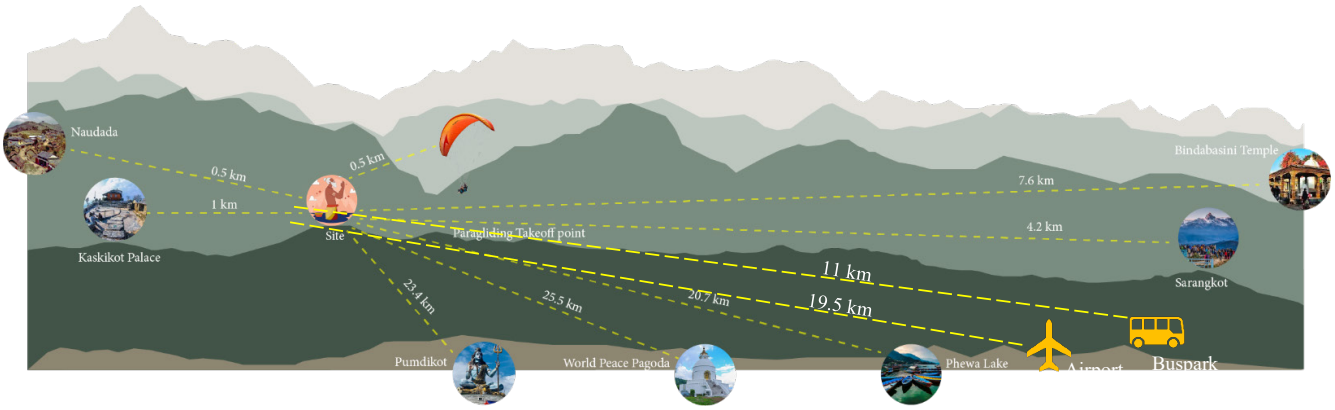

Figure 3-2 Site proximity

3.2 Bylaws:

- Zone: Residential zone
- Building type: Hotel
- Floor area ratio: 2.5
- Allowable ground coverage: 50%
- Set-back for building: 5m.

4 Architectural design Concept

4.1 Kaskikot as a fort

“Fort” is an architectural marvel steeped in grandiosity and strategic prowess, is an impregnable bastion meticulously crafted to withstand the ravages of time. With its formidable ramparts towering aloft, it stands as an indomitable sentinel, epitomizing strength, and security.

Kaskikot can be likened to a fort due to its advantageous geographical location. Perched atop a hill, it offers strategic vantage point, affording the commanding views of the surrounding landscape. The elevated position provides a natural advantage in terms of surveillance and defense against potential threats. The general concept of the fort is to protect the surroundings within it through the fortified walls. The fort here aims to preserve the heritage of Kaskikot.

4.2 Integration of Natural and cultural heritage:

Figure 4-1 Natural and cultural heritage of Nepal

4.2.1 Natural heritage:

Natural heritage in Pokhara encompasses the pristine elements of its environment, including the majestic mountains, serene lakes, and the precious materials that bestow an invaluable splendor upon this breathtaking locale. These treasures not only adorn Pokhara's aesthetic charm but also serve as the bedrock of its natural wealth, casting an enchanting spell upon all who behold them. The natural heritage in the design emphasizes materials i.e., stone, woods which are most prevalent in heritage of Pokhara as it complements the Kaskikot Village.

4.2.2 Nepalese architecture as Cultural Heritage

The cultural heritage is to be inspired by the Nepali architecture. The general characteristic of Nepalese architecture incorporates:

- Courtyard planning and human scale design

- Traditional materials and design

Connection between fort and Nepali architecture:

The edifice extends a warm invitation through its crafted human-scale design, with an entrance that unfolds into a grandiose lobby. A seamless and awe-inspiring synthesis emerges, bridging the distinct realms of architecture and the fortification aesthetics.

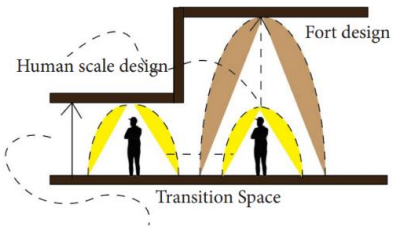

Figure 4-2 Transition space of fort and Nepalese architecture

Courtyard as a communal Space

The courtyard stands as a quintessential communal space, embodying the essence of traditional living and social interaction. It transcends its physical dimensions, fostering a sense of community and unity. The water bodies in the central courtyard engage the guests to dwell in the natural heritage of the design.

Visual connection to design :The architectural composition is thoughtfully crafted to embrace the magnificent vistas of Kaskikot Durbar, with a deliberate focus on its west orientation. This orientation has been carefully chosen to showcase a captivating museum that weaves together the rich tapestry of Kaskikot and Gorkha Durbar's illustrious history.

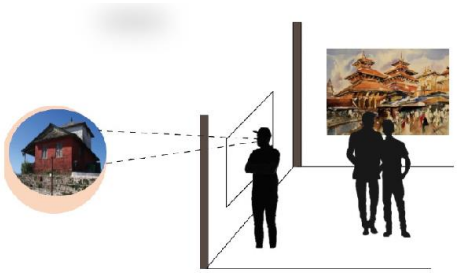

Figure 4-3 Visual connection

5 Masterplan:

Figure 5-1 Masterplan

With a clear focus on celebrating Pokhara's heritage, our zoning prioritizes immersive guest experiences guided by the surrounding natural and cultural wonders. The northern axis offers stunning views of the Annapurna range, inspiring us to position accommodations on the first floor to ensure unobstructed vistas. Our lobby welcomes guests with the grandeur of Kaskikot and Lamjung Durbar's cultural heritage, while the restaurant, conveniently adjacent, caters to both in-house guests and visitors. The museum resides in the west, offering insight into Kaskikot palace, with the presidential suite atop this historical gem. Lastly, all recreational activities are thoughtfully placed along the northern axis for maximum enjoyment.

6 3D images

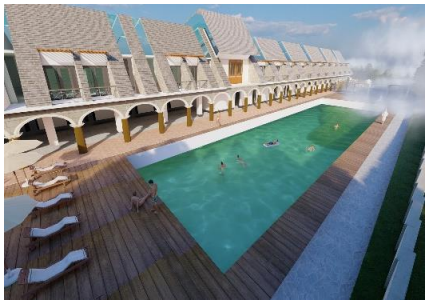

Figure 6-1 North axis with pool view

The northern facade of the building boldly emulates the majestic mountain range, with accommodations featuring expansive balconies that beckon guests to immerse themselves in the awe-inspiring grandeur of Pokhara's true essence, as if cradled within the towering peaks.

The construction materials predominantly are a combination of stone and wood, an homage to the enduring legacy of nature's gifts. The recurring motif of arches within the design pays homage to this tradition.

Figure 6-2 Courtyard view

The courtyard is an orchestrated symphony of water features, with a central pati serving as a tranquil nexus for guests to leisurely explore the hotel's verdant environs, immersing themselves in the embrace of the surrounding natural legacy.

Figure 6-4 Museum with seating space

Figure 6-5 Balcony overview

Figure 6-6 Bedroom interior

Figure 6-7 South profile elevation

Figure 6-8 North profile elevation

7 Conclusion:

In conclusion this thesis significantly contributes to our comprehension of the intricate nexus between architecture, heritage, and the hospitality sector, reaffirming the enduring value of preserving our architectural heritage for generations to come. It ensures the architectural integrity of Pokhara and its heritage to be celebrated throughout.

AUTISM CENTER

Salina Gautam, Roshani Subedi
Department of Architecture, Pokhara Engineering College, Pokhara University
Corresponding e-mail: gsalina05@gmail.com

Abstract

This research is done for the completion of a bachelor's degree on Architecture Engineering. Architecture is not just the relation of spaces with people but peaceful and healing interaction with people, surroundings, and space. It can be designed in a way to heal spiritual, mental, physical well-being. The purpose of the study is not to create a space to collect PWA but to make a space which can interact with them and give the sense of belonging to this community. The main aim is to erase that blur line between PWA and community.

According to the Centers for Disease Control and Prevention (CDC), about 1% of the world's population has autism spectrum disorder – over 75,000,000 people. That may be a large number, but autism spectrum disorder (ASD) features a wide range of symptoms and levels of severity. It is estimated that worldwide about 1 in 160 children have ASD. It is estimated that there are about 2,50,000 - 3,00,000 Person with Autism (PWAs) in Nepal. Among them about 60,000-90,000 PWAs are severely affected.

In this research, study of the design intervention, guidelines, and techniques for PWA are done. It also covers the spaces required according to their needs of them and their barriers. Both physical and psychological barriers are studied with the aim of learning more about their relationship with space as problem solving.

Architecture is one of the few design mediums that requires full physical interaction. Creating responsive, sensory environments and multi-sensory approach along with physical spaces that support increased mind-body connection, help develop skills, and expand social interaction could be a powerful tool in the treatment of autism. Thus, this research aims to do design intervention for person with autism.

1. Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder that affects communication, social interaction, and behavior. Children with autism often face challenges in adapting to new environments, making social connections, and engaging in everyday activities. An autism center that caters to the needs of young children can provide a supportive and inclusive environment where they can receive the necessary therapy and educational services [1] [2].

1.1. History

In recent years, there has been a growing movement to improve the lives of people with autism in Nepal. Several non-government organizations have been established to provide resources and support to families affected by autism, and there have been increasing efforts to raise public awareness and understanding of the condition. There is also a growing body of research on the prevalence and characteristics of autism in Nepal [1] [2].

1.2. Symptoms

The symptoms of autism can vary widely from person to person, but some common signs and behaviors may include:

- **Difficulty in social interaction**: They may have difficulty with social interactions such as making eye contact, recognizing social cues, or initiating conversations.
- **Repetitive behaviors and routines**: Such as rocking, flapping their hands, or repeating certain words or phrases. They may also have rigid routines or a strong attachment to certain objects or toys.
- **Sensory sensitivities**: They may be highly sensitive to certain sensory inputs, such as loud noises, bright lights, or certain textures. This can lead to difficulties in processing sensory information and may cause discomfort or distress.
- **Delayed language development**: They may have delayed language development or struggle with verbal communication.
- **Difficulty with nonverbal communication**: PWA may have difficulty interpreting or using nonverbal communication such as facial expressions, gestures, and body language.

1.3. Causes

The exact cause of ASD is still unknown. Theories about the etiology of the disorder have evolved over time. In the past, faulty child-rearing was thought to be a contributing factor, but this theory has been rejected based on research indicating that the disorder is multi-factorial with a strong genetic component.

1.4. Degrees of Autism

Level 1 Autism: Requiring support.

A person who meets the criteria for level 1 may face social challenges that require some support. They may find it difficult to:

- initiate conversations with others
- respond as others would expect.
- maintain interest in the conversation as a result, it can be hard to make friends, especially without the right support.

Level 2 Autism: Requiring substantial support.

People who meet the level 2 criteria need more support than those with level 1 autism. Social challenges can make holding a conversation very difficult. Even with support, the person may find it hard to communicate coherently, and they are more likely to respond in ways that neurotypical people consider surprising or inappropriate. The person may:

- speak in short sentences.
- only discuss very specific topics
- have difficulty understanding or using nonverbal communication, including facial expression.

Level 3 Autism: Requiring very substantial support.

Among autistic people, those with level 3 autism will need the most support. They will find it very difficult to use or understand verbal and nonverbal communication. The person may:

- avoid or limit interaction with others.
- find it difficult to join in imaginative play with peers.
- show limited interest in friends.
- have difficulty forming friendships [3].

1.5. Diagnosis

The diagnosis of ASD involves a combination of strategies such as comprehensive developmental history, behavioral observations, and standardized assessments. There are several screening tools that are commonly used in the diagnosis of ASD. These include:

- **Modified Checklist for Autism in Toddlers (M-CHAT)**: This is a screening tool designed for children between the ages of 16 and 30 months. The M-CHAT consists of 23 yes-or-no questions that assess a child's communication skills, social interaction, and behavior.
- **Social Communication Questionnaire (SCQ)**: The SCQ is a screening tool that assesses social communication skills and repetitive behaviors in children aged 4 years and above.
- **Autism Diagnostic Observation Schedule (ADOS)**: The ADOS is a diagnostic tool that assesses communication, social interaction, and play in children of all ages. It involves a series of structured activities and tasks that are designed to elicit specific behaviors.
- **Childhood Autism Rating Scale (CARS)**: The CARS is a diagnostic tool that assesses the severity of autism in children. It consists of 15 items that measure social interaction, communication, and behavior.
- **Parents' Evaluation of Developmental Status (PEDS):** is a general developmental parent-interview form that identifies areas of concern by asking parents questions.

1.6. Senses in Autism

The traditional five senses are sight, hearing, touch, taste, and smell, but individuals with autism may experience differences in sensory processing beyond these senses. It can affect their balance, motor skills, and body awareness. Seven senses that are sometimes associated with autism include:

- **Sight:** Individuals with autism may have differences in processing visual information, such as sensitivity to bright lights or difficulty filtering out visual distractions.
- **Hearing:** Some may have heightened sensitivity to sounds or difficulty processing auditory information, which can make it challenging to filter out background noise or understand speech in noisy environments.
- **Touch:** Differences in processing touch sensations, such as being overly sensitive to certain textures or materials, may occur.
- **Taste:** Some may have a limited range of foods they are willing to eat due to differences in taste perception or texture.
- **Smell:** Some may be more sensitive to certain smells or find certain scents overwhelming or unpleasant.
- **Proprioception:** This is the sense of body awareness and position in space. Differences in proprioceptive processing can affect motor coordination, balance, and spatial awareness.
- **Vestibular:** This is the sense of balance and movement. Differences in vestibular processing can affect the ability to process motion or the comfort level with certain types of movement, such as spinning or swinging.

1.7. Sensory Differences in ASD

These variations in sensory perception can cause discomfort, anxiety, confusion, or disruption, leading to abnormal behaviors as they try to filter out unwanted stimuli [4].

Intensity

- Hypersensitivity: Being hypersensitive to something means having an excessive physical sensitivity towards substances, medicines, light, smell, touch, and other stimuli.
- Hyposensitivity: Being under-sensitive to stimulation. It is the opposite of hypersensitivity where the sensory channel is not open enough, and as a result, not enough information gets to the brain, leading to deprivation.

Sensory Overload

Sensory overload can occur when an individual's sensory systems become overwhelmed, causing discomfort that can range from mild to severe. This can happen in various situations, such as being in a crowded place, encountering loud noises, or being exposed to strong odors.

Gestalt Perception
Gestalt perception refers to the brain's process of interpreting sensory information, rather than as individual components. This process applies to all senses. People with gestalt perception may find it challenging to focus on specific details in a scene because they cannot separate them from the overall perception.

Fragmented Perception
Fragmented perception is a common issue for individuals with autism, which occurs when they struggle to break down complex information into meaningful units. This can result in processing only a part of a scene or sentence while ignoring the rest.

Delayed Processing
Individuals with autism may experience delayed processing, which means the perception process takes a longer time compared to neurotypical individuals. This can make it difficult for them to understand or learn new things. Too much information at once can cause processing delays.

Compensation
When individuals experience fragmented or distorted perception or delayed processing, they may rely on their other senses to compensate and better understand their environment. Touch and smell, which are typically more reliable senses, are commonly used by children to explore and gain a better understanding of their surroundings.

Sensory Shutdown
In cases of sensory overload, however, individuals may experience sensory shutdowns where they are unable to process all the incoming information.

2. Site Analysis

The selected site is in ward no. 11 of Pokhara, Fulbari. The site is located just outside the city core, placed in a suburban context, the site presents the opportunity to connect with both nature and community. The site is in reasonable proximity to well-known medical institutions as well as schools and day care centers. The site lies in a residential area. The area of the proposed site is a total of 25 ropani.

2.1. Site Selection and Criteria

- Site selected should be in residential area.
- Should be away from highways, traffic and crowded areas which is peaceful and quiet.
- Should be easily accessible to cater people.
- Natural environment for healing and rehabilitation
- Hospitals or health post nearby
- Schools nearby
- Basic facility provision

Figure 1 Site

2.2. Site Justification

- Located in peaceful area and on outskirts of Pokhara Valley.
- Located in residential area.
- Schools are located around the site.
- Hospitals are nearby in case of emergency.

- The site is away from highway traffic and crowds in a quiet environment.

2.3. Bye Laws

- Residential and Governmental
- Building Type: Educational Institution
- Floor Area Ratio: 2.0
- Allowable Ground Coverage: 50%
- Right of Way: 4m
- Setback from front: 2.5mSetback from back/ side: 1.5m

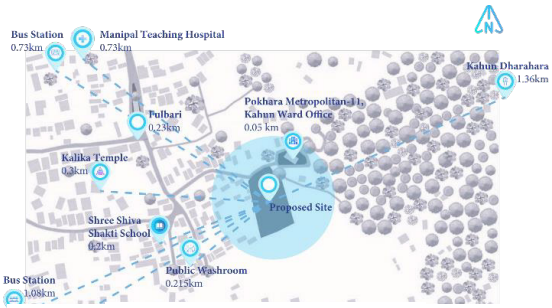

Figure 2 Site Approaches

3. Concept

HEAL WITH NATURE

How can architecture heal?

- Design strategies to improve mental health.
- Involving individuals with autism in health-promoting activities and social interactions.
- Integrating nature.

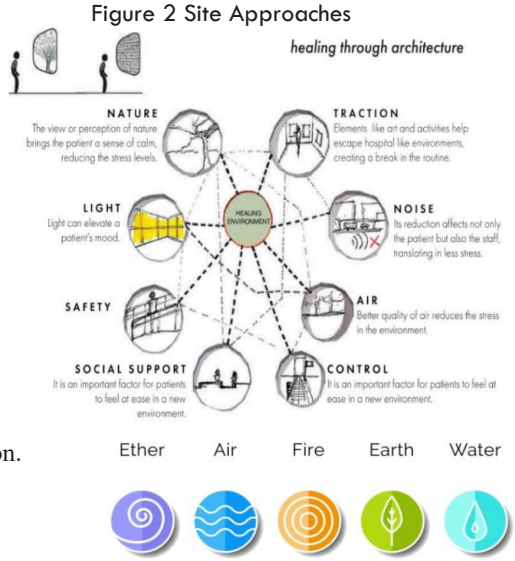

Figure 3 Elements of Nature

Approach 1: Transition Space

- Transition Spaces through building orientation.
- Buffer through nature.
- Buffer through building orientation.
- Connection between buildings.
- Sensory Corridor.

Transition spaces can be designed to provide sensory support and regulation. They can offer opportunities for individuals with autism to engage in activities that help them transition from one sensory environment to another. These activities may include sensory integration techniques, such as deep pressure touch, vestibular input, or proprioceptive activities.

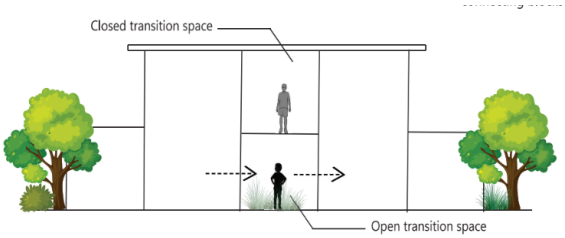

Figure 4 Transition Space

Approach 2: Perception and Penetration of Geometrical Shapes

As way of perception of an autistic child is different from neurotypical child, and psychological perception takes place an important role in child. Due to which psychological perception of shapes was studied and two different forms i.e., square and rectangle were taken into consideration while designing master plan.

Square: It gives a sense of reliability and security, stability and efficiency and make child feel safe and contained.

Rectangle: It allows for more straightforward organization of rooms, corridors, and common areas.

After penetrating the shapes, curve shape was used to enhance the flow and circulation within the autism center. This can reduce the risk of congestion, create a more open and spacious feel, and minimize potential sensory overload associated with narrow or confined spaces.

Approach 3: Courtyard Planning

Courtyards can serve as transitional spaces within an autism center, providing a bridge between the indoors and outdoors. They can be designed to accommodate different activities and purposes, allowing for flexibility in programming and therapy sessions. This flexibility enables individuals to transition smoothly between different areas of the center and adapt to various therapeutic and learning environments.

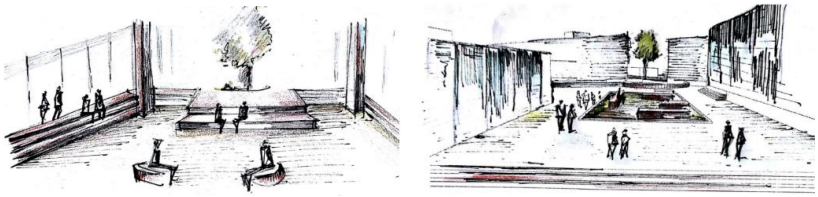

Figure 5 Courtyard Planning

3.1. Form Development

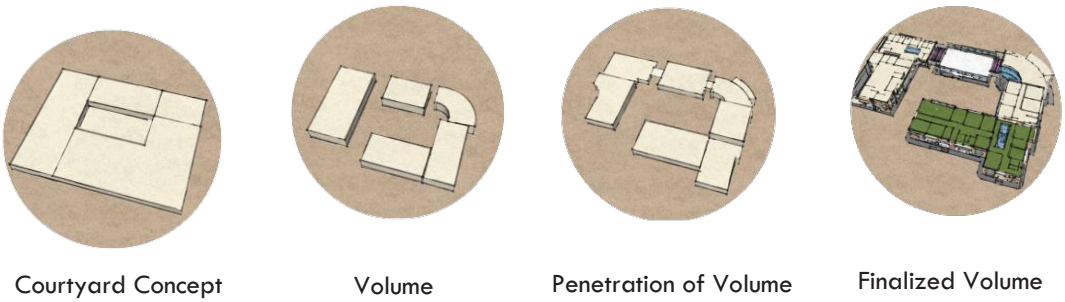

Figure 6 Form Development

3.2. Masterplan Development

Considering the flow of process in the center, the site will be divided into four different zones i.e., Admin and Diagnosis unit, Vocational Training unit, Therapy unit and Academic unit.

The site consists of two entrances, one from the northern portion; primary road, for vehicular and pedestrian entrance separated by vegetation and bollards and the other service road is provided on eastern side for service.

Figure 7 Masterplan Development

3.3. Administration and Diagnosis Block

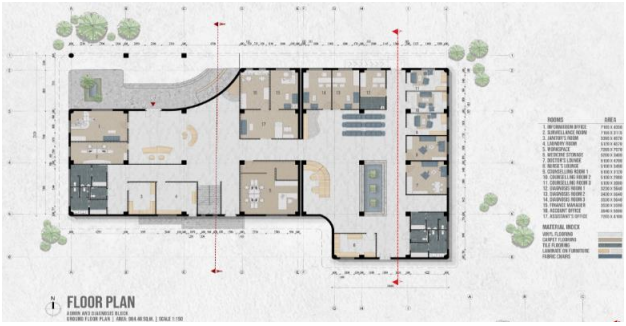

Figure 8 Ground Floor Plan

The administration block is easily visible from the entrance and is accessed through the main axis. This unit houses the administrative services and diagnosis unit. Diagnosis unit can be accessed directly from main entrance as some PWA can visit only for diagnostic purpose. The entrance leads directly to the reception from where the visitors can be guided.

Figure 9 First Floor Plan

3.4. Academic and Training Block

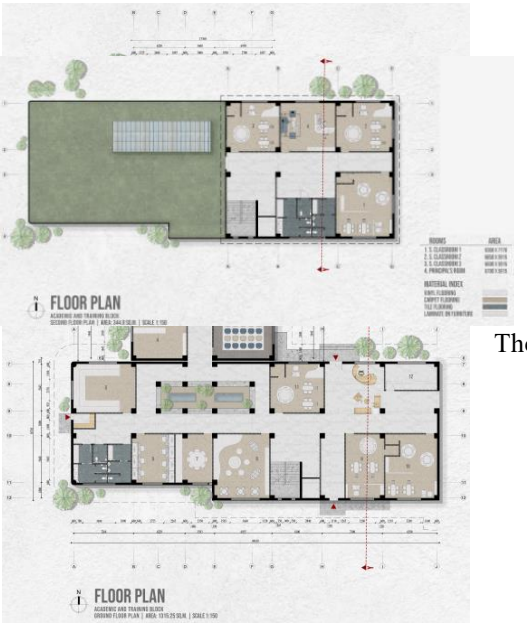

Figure 11 Ground Floor Plan

Figure 10 First Floor Plan

The academic block is directly visible from courtyard. Considering the existing site feature and natural setting the academic block has been placed in the southern side. The location is also preferable for the optimum use of maximum daylight. The block is divided into two part and half floors i.e. Primary, Secondary and Senior Level.

Figure 12 Second Floor Plan

3.5. Therapy Block

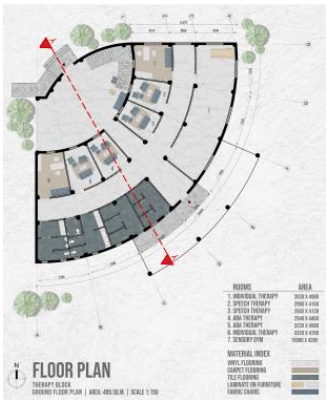

Figure 13 Ground Floor Plan

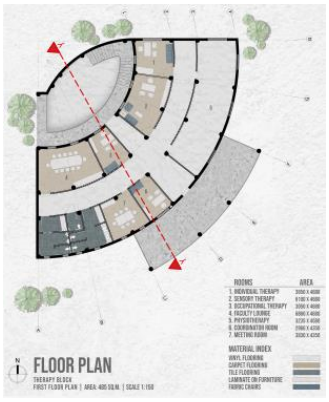

Figure 14 First Floor Plan

Therapy block and academic block are connected through lobby. First floor consists of therapy units and a balcony to connect the visitors and students to the nature and to get mesmerizing view of sensory garden.

3.6. 3D Images

Entrance

Academic and Training Block from Courtyard

Transition Space

Playground

Playground

Courtyard

3.7. Sciography Elevations

Figure 15 West Elevation

Figure 16 East Elevation

Figure 17 South Elevation

Figure 18 North Elevation

3.8. Sensory Garden

Touch

Five Senses of Sensory Garden

Hearing

Taste

Smell and Visual

4. Conclusion

The space should be simple, calm and predictable. The built space should be able to evoke a sense of security and comfortable belonging. The design should be able to maintain the delicate balance of stimulus levels, as overstimulation is the major cause for behavior issues in autism. Need of easy transition, predictable flow, visual signage and representations, escape space for recalibration and safety must be given due consideration so that individuals with autism can independently experience the space.

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TOURISM HUB-LAKEFRONT REALM

Utsabi Thapa, Rojana Joshi
Department of Architecture, Pokhara Engineering College, Pokhara University
Corresponding e-mail: Utsabithapa6126@gmail.com

Abstract

This research is done for the completion of a bachelor's degree on Architecture Engineering. The topic I have chosen for my thesis is "Tourism Hub- Lakefront Realm". Architecture can make spaces into places. Places where everyone is invited and create experiences and memories of their own. Placemaking horizons now have been extended to waterfronts. The development of waterfront realm for a touristic city is what this research tries to unravel.

Tourism Industry is an ever-growing economic approach to any place. Especially in cities like Pokhara which has so much to offer with nature built and cultural built heritages, can have many profitable values through tourism. To provide tourists with the wholesome experience it's important to engage tourism products in a project. "Tourism Hub" hence is a common ground for all the tourism products to be in s single location. This experience must include activities related to the city, combined approaches towards natural and intangible attributes, involvement of domestic tourist, regional tourist, international tourist and local people.

This research looks into the history of tourism with listing of appropriate functions needed in the project, relations between spaces, placemaking attributes, placemaking and waterfront development and many more in literature review. While same topics and common knowledge is gained from the case studies researched on this report.

1. Introduction

"Tourism is a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes" defined by United Nations World Tourism Organization (UNWTO). Capturing those movements into an experience where the visitors are provided with different types of tourism products in a particular destination known as tourism hub.

1.1. History

Looking back at the timeline of tourism, it seems to be seen as early as nomadic people's lifestyle and found itself evolving through the "Grand tour", to being coined in 1930's, to people scorching through various destinations of Roman and Greek site seeing and being today's one of the biggest economies globally, tourism is also considered as the major economy influencing economic factor for our country Nepal as well. After the embarkment of Mt. Everest by Edmund Hillary and Tenzing Norgay Sherpa the tourism is acknowledged and seem to have a sustaining pattern despite of the unfortunate events like 2015 earthquake, riots for democracy and even covid-19.

1.2. Tourism Scenario in Nepal

According to Nepal Tourism Statistics, arrival of international tourist in 1964 was quite low with population of 9526 which was first data to be recorded. While in 2006 the population of arrival reached up to 383926 while the highest peak of population was reached in 2019 with population of

1197191 [1]. Analyzing these data, tourism in Nepal is seen to be flourishing. There are some negative fluctuations in statistics of tourism intake in Nepal which can be observed in (1994-2002) due to civil war and in recent events like global pandemic 'Covid-19'. But tourism in Nepal is returning to normalcy. 2023 spring season witnessed a considerable number of foreign tourists arriving in Nepal with a total of 42,006 tourists coming via air route in March alone while last year in 2022, 14,977 foreign tourists had visited Nepal during the same period. According to statistics of the Department of Tourism, Nepal has received a total of 78,747 foreign tourists from January to March end this year [2]. Tourism in Nepal has seen exponential growth in the last few years. With any mishappens globally or nationally tourism in Nepal also observed to recover simultaneously.

1.3. Tourism in Pokhara

Located in the central Nepal lies one of the world's most attractive tourist destinations with the perfect blending of the unparallel prettiness of nature and mystery of culture, Pokhara. . Valley is full of unlimited natural attractions, cultural beauties, biological diversities and ultimately has become a proud-worthy spot of Nepal. The spectacular views of scenic Annapurna Himalaya range, the shortest distance of snowcapped mountains (Mt. Fishtail on just 28 km away), the harmony of exotic mountains, eye catching lakes and the mystical form of Machhapuchhre mountain reflected into Fewa Lake, are the praise worthy features of Pokhara that have made to fascinate thousands of tourists, especially from abroad.

1.4. Touristic Destinations in Pokhara

Natural Heritages

Natural heritages are the major touristic destinations ensemble activities like site seeing, trekking, souvenirs, paragliding, ziplining and even bungee jumping. The fresh wisp of nature surrounds the touristic experiences throughout. Some of the touristic destinations are

- Mt Macchapuchre (Annapurna Himalayan Range)
- Fewa Lake, Begnas Lake, Rupa Lake (Seven Lakes of Pokhara)
- Bhim Dhunga
- Seti River Gorge and K.I Singh Pool
- Bat's Cave
- Devi's Fall
- Kaskikot and Sarangkot
- Ghandruk

Cultural Heritages

People of different ethnic groups live with pride and harmony in Pokhara, making it a city of different cultural heritages. These heritages mark the faith of the people towards their beliefs and their religion.

- Tal Barahi Temple
- World Peace Stupa
- Gupteshwor Mahadev
- Bhadrakali Temple
- Bindhawasini Temple
- Bhairav Temple and many more [3]

Events and Festivals

Many events and festivals are seen yearlong in the infamous Pokhara's calendar. From celebrating economic factors through Mahotsavs, to lhosar and jatras celebrations, teej festivities, sports celebratory events, concerts and many more there are some unexplored and rising festivities in demand as well [3]. Festivals like 12-Barsey Lakhey Naach and Tiji Festivals are needed to be highly advertised to bring in large number of tourists to experience such rare gems.

1.5. Tourism Development Plans of Pokhara

Looking back at touristic developments there are many development plan initiations for Pokhara [3]. The three highlighted development plans are:

Tourism Master Plan of 1972: Basically, sees Pokhara as a total recreational zone and developments of lodges and resorts being respectful towards the landscapes.

Pacific Area Travel Association (PATA) Development Authority, 1975: Touristic developments with key points like the lakes, town and recreation.

Integrated tourism development plan for Pokhara by International Finance Corporation: The plan-initiated developments along the lakefront area and the lakes itself. The plan saw fit a large area in the lakefront as a public place with water shows, plazas, foot tracks being constructed.

Being mindful of the heritages and the development plans "Tourism Hub- Lakeront Realm" was seen a perfect match for current conditions of Pokhara, a touristic lake city. A public place for recreation, information, socialization and economical trading in front of the lake.

1.6. Placemaking and Waterfront Development

As continuing the project, it was essential to learn the basic principles for a public placemaking in the lakefront area. Where there were four main attributes for placemaking like:

- Access and Linkage
- Comfort and Image
- Use and Activities
- Sociability

Principles of Waterfront Development were site planning, services along the waterfront area, infrastructure with activities that doesn't hamper the water resource, preservation of the bank, street use and landscape, access and transportation and land use and facilities.

2. Case Study

As the project was a hub housing multiple programs and a place for public there was a wide range of case study both in terms of national and international.

2.1. National Case Study

Nepal Tourism Board: The arrangement of service area, museums and auditoriums to incorporate with different touristic flows in the building with the sense of use of local materials and style.

Taragaon Museum: The sociable semi private space which is favored by all and is revisited to experience the open and closed space connection, lights and visual of nature while being designed in modernism which is respectful to the surrounding architectural style.

BabarMahal Revisited: A commercial space, public space and recreational space placed all in one place creating a social space for everyone.

2.2. International Case Study

Ice Cubes Xinxang Tourism Center: An abstract design for a proper representational design of the city. Use of modern technology whilst staying respectful towards nature and being a great example of a structural marvel.

Tel Aviv Central Promenade: The revival of ocean front through creating different activities throughout the waterfront area which is created in a fluid term which connects the city and the waterfront.

Patna Riverfront Development and Revitalization: The Revitalization by developing the 7kms ghat stretch into a place housing different recreational activity, public open spaces and landscaping.

3. Site Analysis

The site is located on Sedi Khola Height, Lakeside, Pokhara-06. The site is located about 4.4km away from the center of Pokhara, a touristic city with a wide range of destinations. With gently rolling terrain leading to the flat land site has a tentative area of 27595m^2 (54.24 Ropani). Currently the site functions as site seeing and farmland. The site has south- north orientation and is surrounded amongst RCC built buildings proving the possibility for new built structures.

Figure 1- Location and Approach of Site

3.1. Site Selection and Criteria

- Site should be situated at lakefront.
- Site should be easily accessible and accessed by public transport system.
- Site should have maximum influence of natural environment.
- Should be amongst some touristic destinations of Pokhara.
- Should be where there is proper public engagement already.
- Site selected should be in residential area.

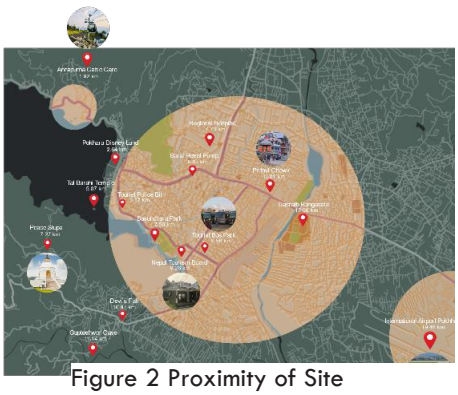


Figure 2 Proximity of Site

3.2. Site Justification

- Site is located in highly tourist concentrated area.
- Site is located in lakefront area.
- Location is in a natural area.
- Potential for site extension.
- The site possesses a solid relationship with the hosting environment.

3.3. Bye Laws

- Zone: Commercial
- Building Type: Public Building
- Floor Area Ratio: 3.5
- Allowable Ground Coverage: 50%
- Right of Way (ROW): 60ft
- Setback from Lake: 65mSetback for building: 5m from ROW

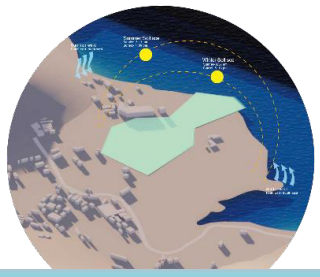


Figure 3 Site Sun Solstice

4. Concept

HARMONIZING EXPERIENCES WITH NATURE

The project started taking shape with the concept of ***"Harmonizing Experiences with Nature".*** While the project is providing different set of experiences to the visitors with various programs, feeling of intimidation can rile up to anyone at any time. So, to eradicate such intimidation and create both physical and emotional connection by introducing nature as a common ground or a familiar space for everyone. On the contrary, we human always tend to go back to nature all the time either with our conscious or subconscious mind and it's only fair for an image of a place to be fresh in our minds when there's an emotional connection which is interwind with nature or is harmonizing with nature. The harmony adds character of timelessness to the project which according to Frank Gehry should be in respect to its time and place. The concept values five elements of nature and elaborates it in various terms like light and shadow, open and void, interpretation of nature, harmony with nature and live experiences.

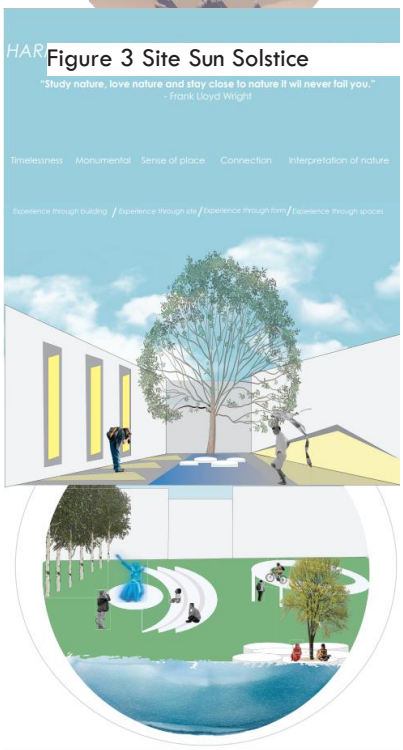


Figure 5- Concept

Approach 1: Light and Shadow

While creating harmony between experiences and nature, experience through building can be observed through light shadow. The manipulation of light inside the building can influence the spiritual quality of a space. Manipulation through openings in the building frame, uses of different glasses and even building orientations can be done to create different sensations.

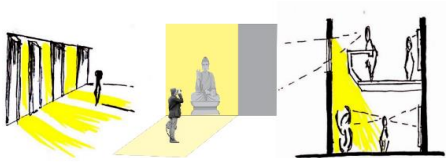


Figure 6- Conceptual Sketches

Approach 2: Interpretation of Nature

Bringing the nature inside the building and even providing visuals of nature can also harmonize experiences and nature. Like reflective surface design (faced towards lake), sliver of openings in building facades and many other design approaches. Visual of Nature are point of sights

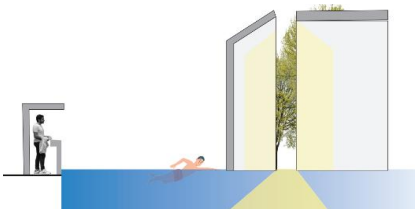


Figure 7- Interpretation of Nature

that are used as designs. Sights from reflective façade design, sliver of openings which are splayed encouraging light with view of sight.

Approach 3: Harmony with Nature

As for harmony with nature, the plant "Water Hyacinth" is taken as a reference for biomimicry design. The leaves of the water hyacinth are rounded kidney shaped which are spongy. Water Hyacinths are lake predators which are to be extracted from the lake these hyacinths can also be used to make fabrics that can be sold in souvenir shop.

Figure 8- Abstract as per biomimicry of water hyacinth

Approach 4: Void and filled

Maintains the spiritual quality. Open to air space throughout the design. Void can be also used in spaces like museum and library spaces to develop connection in elevation. "If you give people nothingness; they can ponder what can be achieved from that nothingness." Tadao Ando. With this quotation void can be introduced in areas like museum where people can feel nothingness even in chaotic environment.

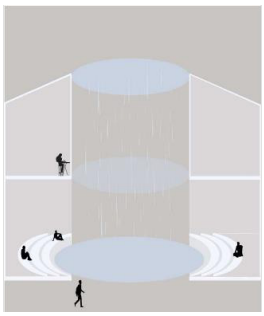
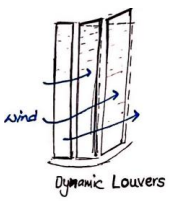


Figure 9- Void and Filled

Approach 5: Live Experiences

Harmonizing experiences with nature can extend to elements like wind from lake can be used for winds dynamic louvers can be used as louvers required in it seems like the building is in motion. Live include interactive fountains with seating areas. Live in motion art can also be introduced as live experience.

live experience. Nature coop processes. The south side facing lake so experiences can also art museums and water



Approach 6: Design Guided by Site

Certain concepts and designs were demanded by the site itself. The merging interaction line between by creating a cascading lakefront area which is also effective when there's seasonal lake flooding. Also, the existing water way is built with a water hyacinth bridge with respect to the concept.

Figure 10- Bridge creation and Merge of Interaction Line

4.1. Form Development

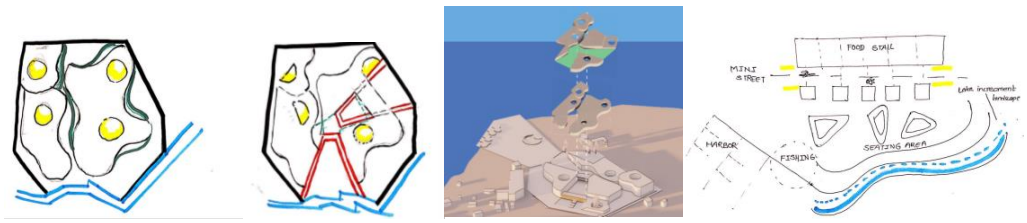


Figure 11- Form Development through site, through building and lakefront

4.2. Masterplan Development

Development in site is seen with building forms which dwells organically from the gentle rolling low terrain land and is located in accordance with private, semi private and public spaces. A line of sight of north-south is created which allows an unobstructed view of the lake which merges with different public nodes in the site and all the three major site entrances. The east entrance is provided with reflective pool to mimic the experience of walking on the lake and imitations of existing foot track of Pokhara. Then through the entrance programs like visitor center, administration, library is accessible. Apart from library lies museum which is solely dedicated to all the essences of Pokhara's identity. Then arrives the recreational block which has a green belt forming in adjacent with the line of sight which provides a transformational experience of the site. The main node of the site consists of retractable pavilion which is again the mimicry of the water hyacinth and is powered by solar energy and tends to retract at night and open wide in day time.

Figure 12- Master Plan

4.3. Visitor Center and Recreational Block

The visitor center has an information booth with an administration consisting tourist service department which includes one of the voids which brings the nature inside the building. Following the admin part lies auditorium hall and food court.

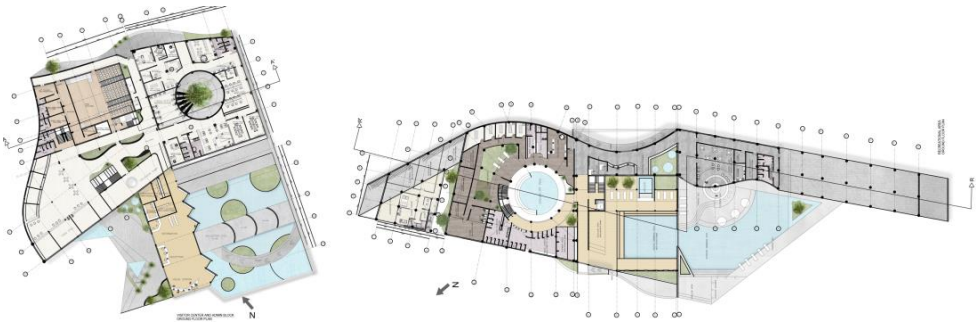


Figure 13- Ground floor plan of visitor center and recreational block

The recreational block has a well-functioning spa with a void used as cooling off area and fitness center with indoor-outdoor swimming pool and two restaurants with astonishing lake views. Both blocks are connected in first floor through a bridge which starts and ends in areas inviting public attentions.

Figure 14- First Floor Plan

4.4. Museum and Library

The library is accessed through the visitor center which has a reference section, children section and a raised seating collaborative space. The library has a spiral staircase surrounding a tree. The museum and library share a glass covered undulated pathway connecting different areas in the site.

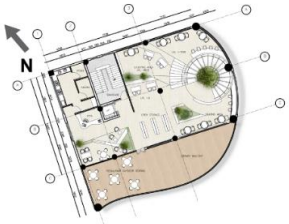


Figure 15- Second Floor Plan

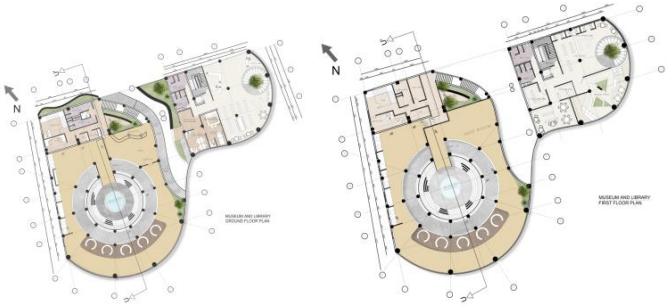


Figure 16- Ground Floor and First Floor Plan

The museum is an absolute representation of Pokhara with a spiral ramp, live thank painting area, water museum and a look out window area. The museum consists of a green infused staircase as a clear route of exit.

4.5. Lakefront

The second half of the thesis topic “Lakefront Realm” experiences a transformational and connective space with the hub. With a continuing ramp from north-south entrance and a gradual arrangement of height differentiating structure the building experiences connectivity with the lake. The exhibition

pavilion and eat street follow the patterns of the throughout project leading it to the lakeside. The lakeside area has access to walkways. Cycle lanes and interactive waterbodies with a boat parking and a fishing deck which provides a wholesome lake experience. The open-air theatre also plays a great role in adding the interactive factor to the site with possibilities of evening activities.

4.6. Space Accessibility

For a hub to function without any unwanted mass flow disturbances it's important to categorize spaces into private, semi-private and public spaces. As seen in the axonometric representation private areas like admin parts and services are not accessible to anyone but the connection to semi-private and public is done through connections of nature like voids, green belt ramps and public green staircases.

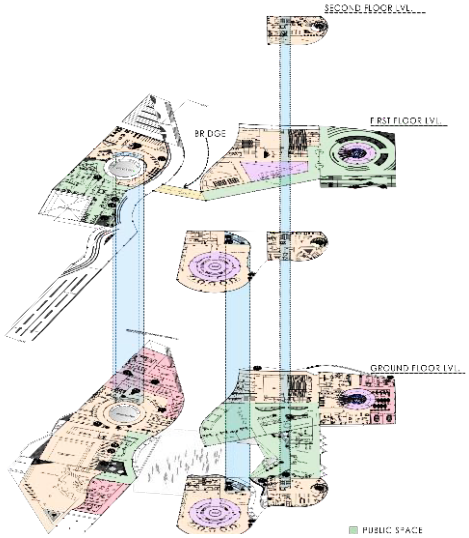


Figure 17- Axonometric showing space accessibility

4.7. 3D Images

Figure 18- Bird's Eye View of the Site

Figure 19- Different Perspectives of the Hub

Figure 20- Lakefront area

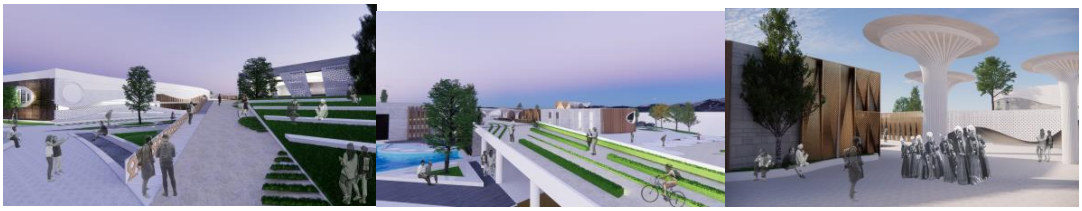


Figure 21- Public Engagement Nodes

Figure 22- Interior Stills

4.8. Sciography Elevations

5. Conclusion

A futuristic landmark which is mindful of modern technology, placemaking attributes, connections between blocks, mass flow and incorporates nature which creates a serene place for interactions, recreations and celebrations. The lakefront oasis provides an exemplary possibility to a touristic city

which in current times is in prior need of a place which identifies, is beneficiary and a place where people can visit numerous times.

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THE DIVERSE ROLES AND EFFECTS OF ART CENTERS IN CONTEMPORARY SOCIETY

Prakriti Gautam
Email: prakritigautam0963@gmail.com
Department of Architecture
Pokhara Engineering College, Pokhara University, Nepal

Abstract

Art Centers play a pivotal role in nurturing creativity, fostering community engagement, and facilitating cultural exchange in the realm of the arts. This article explores the multifaceted functions and impacts of Art Centers within contemporary society. Drawing on a comprehensive review of literature, case studies, and interviews with artists, this research investigates the ways in which Art Centers aims to cultivate and promote artistic creativity and cultural enrichment within its community and beyond.

The study reveals that Art Centers serve as vibrant hubs for artists and enthusiast alike, providing access to diverse art forms and educational opportunities. They act as platforms for emerging and established artists to exhibit their work, promoting artistic diversity and cross-disciplinary collaboration. Furthermore, this article examines how Art Centers serve as agents of cultural diplomacy, connecting artists and audiences across geographical and cultural boundaries. Through international exhibitions, artist residencies, and collaborative projects, these institutions contribute to global cultural dialogue and understanding.

In conclusion, this research underscores the essential role of Art Centers in cultivating creativity, preserving cultural heritage, and promoting intercultural exchange. By providing a dynamic and inclusive space for artistic exploration, these centers contribute significantly to the enrichment of local communities and the advancement of global artistic discourse.

1. Introduction

Art is a vast and diverse field of human expression that involves a wide range of creative disciplines, including visual arts, performing arts, and literary arts. It is a form of communication that allows individuals to express their ideas, emotions, and experiences through various mediums, such as painting, sculpture, drawing, photography, music, dance, theater, and literature.

Art has been an integral part of human history, with different cultures and time periods producing a rich and diverse array of artistic forms. When portrayed on a community level, art helps to connect the community through generation of culture.

An Art Center is a facility or organization dedicated to the promotion, education, and exhibition of various forms of art. It serves as a hub for artists, students, and the general public to engage with and appreciate the arts. Art is showcased in an Art center that provide exhibition space and facilities for artists to display their work in a professional and accessible manner [1].

1.1. History

Art and art centers dates back to ancient times, where artists and craftsmen gathered in communal spaces to share ideas, techniques, and inspiration. Galleries, which are typically spaces where works of art are exhibited for public viewing, can be traced back to the 17th century in Europe. These early

galleries were often associated with wealthy patrons who collected art and used their homes as exhibition spaces. As art became more popular and the number of collectors grew, dedicated gallery spaces began to emerge. Workshops, on the other hand, have been around since ancient times and were originally spaces where artists and artisans could create and collaborate on projects. In the middle ages, guilds were formed to regulate the production and sale of goods, and workshops were essential to the training and education of guild members. As the art world evolved, workshops became places where artists could learn from one another and develop their skills, often under the guidance of a master artist [2].

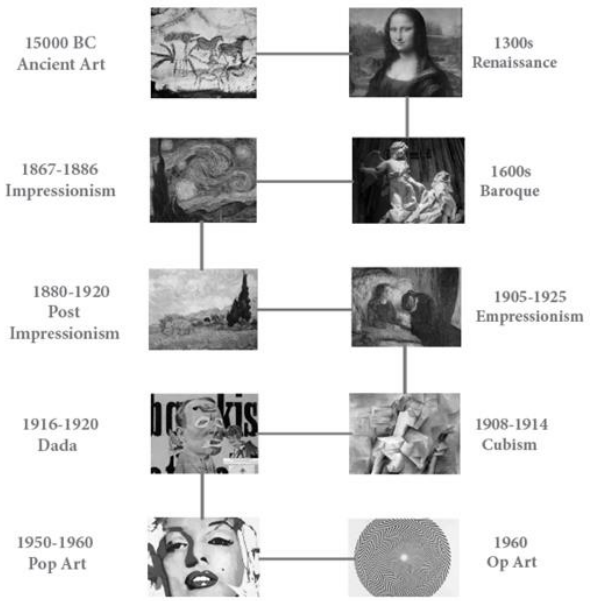


Figure 1 Evolution of Art

1.2. National Context

The history of art in Nepal dates back to ancient times, with the earliest known artworks being found in the form of stone sculptures and carvings from the Licchavi period (400-750 AD). These artworks were primarily religious in nature, reflecting the strong influence of Hinduism and Buddhism in Nepali culture. In the medieval period, Nepali art flourished under the Malla dynasty, with artists producing intricate wood carvings, metalwork, and murals for temples and palaces. The Newar community in Kathmandu also developed a distinct style of art and architecture, characterized by intricate wood and stone carvings, metalwork, and pottery. During the modern era, art in Nepal underwent significant changes, with artists beginning to experiment with new styles and mediums. In the 1950s, a group of artists known as the "Progressive Artists Group" emerged in Kathmandu, who were influenced by modern Western art movements such as cubism and abstraction.

In the 1970s, the Nepali art scene experienced a revival, with the establishment of the "Nepal Association of Fine Arts" and the opening of several art schools and galleries. This led to the emergence of new generations of artists, who began to explore themes such as identity, social issues, and globalization. Despite these developments, the art scene in Nepal still faces many challenges, including a lack of government support, limited access to resources and materials, and a lack of professional opportunities for artists. However, in recent years, there has been a growing interest in Nepali art both domestically and internationally, with artists gaining greater recognition and exposure [3].

1.3. Forms of Art

Visual art encompasses a wide range of artistic expressions that primarily rely on visual perception to convey ideas, emotions, and aesthetics. It is a broad and diverse field that includes various mediums and forms of artistic expression.

Painting

Nepalese art painting originated from manuscript illustrations found on palm leaves. Astasahasrika Prajnaparamita (1015 AD) is the earliest known illustrated manuscript in Nepal. Religion has an incredible impact on such manuscripts and they are usually decorated with mythical figures of divinities. Paintings were mainly done in manuscripts, wood, walls, cloth, or metal plates. Plants, Minerals, and soil were the main sources of colors for these paintings.

Wood Carving

Woodcarving is another integral part of Nepali art and culture that served a decorative purpose in ancient Nepal. Doors, Windows, temples, roof-struts, and others were all carved by hand in the old temples and palaces of Kathmandu valley. Wood carving is a very prominent aspect of Nepalese architecture. Nepalese artwork also influenced other cultures when in the 7th century AD, Mahayana Buddhism got introduced in Tibet under the king Anshu Varma. Various monasteries had sculptures as well. [5]

Stone Carving

One of the most significant stone carving traditions in Nepal is the Newari stone carving, which dates back to the 5th century. The Newari people are an ethnic group in the Kathmandu Valley who have a rich cultural heritage that is closely tied to stone carving. Newari stone carvers are known for their intricate and highly detailed carvings, which often feature traditional motifs, such as gods and goddesses, animals, and geometric patterns.

Pottery Making

Nepal has a diverse range of cultural and ethnic groups, each with their own unique pottery traditions and techniques. Nepal also has a thriving contemporary ceramics scene, with many artists and potters experimenting with new forms, techniques, and materials. From traditional techniques and motifs to contemporary forms and styles, Nepali pottery continues to evolve and inspire new generations of artists and artisans [6].

Figure 2. Thanka Paint

Figure 3. Wood carving

Figure 4. Stone carving

Figure 5. Pottery making

Performance art is a form of artistic expression in which the artist creates a work or event that is meant to be experienced by an audience in real-time. This type of art can take many forms, including dance, theater, music, and multimedia installations.

Dance

Dance, simply described as a series of ordered bodily motions and movements, usually performed with music as its basis. Architectural space is the process of creating volume out of void. Similarly, dance is a movement through space.

Music

Music is arrangement of sound creating rhythm, melody and harmony. Both architecture and music are art forms which are brought together by rhythm from which creativity and ideas are born.

Theatre

Theatre, concerned with acting out stories representing emotions connecting through the audience. Theatre tries to show, express emotions through stories in a form of play, drama, act etc.

Performance art can help to foster a sense of community within the art center and the wider artistic community. By bringing together artists and audiences from diverse backgrounds and experiences, performance art can help to break down barriers and promote understanding and collaboration.

Figure 6. Dance

Figure 7. Music

Figure 8. Theatre

2. Interview

Interviews with artists are essential before designing an art center because they can provide insights and perspectives on the needs and desires of the artistic community. These interviews can help designers and architects understand how artists work, what kind of spaces they need, and how they prefer to interact with their environment. For better understanding of local context of Pokhara, interview of one of the renowned artist was taken.

Hemkanti Gurung
Member of IWS (International Watercolor Society, Nepal Official)
She owns Hemkanti Art Gallery located in Ranipauwa, Pokhara-11.

Questioners

1. What inspired your Artwork?

"Living in a heavenly place like Pokhara, its natural beauty inspire me to work. Also, Living beings, including people and animals provides vision to my arts."

2. What messages do you aim to convey through your art?

"My every work has different message. I am more focused on spiritual behavior and surrounding. We organized exhibitions like NO GUTS NO STORY Season 1 in 2021AD that convey message of

Woman Empowerment. Another exhibition was about Birth, Rise and Old age called THE HIDDEN SOUL that shows each development stage of bad spirit from pure soul of people showing importance of their life and how living condition of present affect the future."

3. What challenges do you face in terms of space while doing exhibitions/ workshops?

"Presently, there is no proper space and we have been doing exhibitions in party palaces. Venue of exhibitions and programs should be selected with the concept and theme but current condition of Pokhara is worse. There are many peope who want to learn but due to absence of proper workshop, facilities and opportunity are not provided"

4. What suggestions would you like to give so to improve the current communal and art spaces in Nepal?

"Nepalese Art should be introduced to the international level. Also, place for workshops, exhibitions, art galleries and programs are needed to showcase the visual and performance art of Nepal. Residences for National and International Artist are also required. "

5. What site criteria would you suggest an Architect for a new Art Center?

"Mostly all artists are inspired by the natural beauty around them. So I would suggest an Architect to create a platform where all the visitors and artists can get inspiration from a serene surrounding with a refreshing view."

The interview helped to design a suitable environment for artist and visitor and helped to learn about the thoughts and views of an artistic point of view.

3. Site

3.1. About Site

The site is located in Komagane Park (Miteri Park Ground) which is in Pokhara City, Lakeside-06. Longitude: 83.9955879 Latitude: 28.237987 Altitude: 822m

Site is in the distance of 0.4km from Sahid Chowk and 2.2km from Hallan Chowk through Lakeside Road. The site has a north-east orientation which is a flat land with some "Indian Rosewood (Shisau)" trees. The area of the proposed site is a total of 35 Ropani.

Figure 9. Site Location

3.2. Bye-Laws

Setback: 5m
FAR (Floor Area Ratio): 2.5
Setback from Lake: 65m
R.O.W: 20m

3.3. Site Justification

- Art and culture preserve heritage, cultural identity, and promote tourism.

- Natural beauty of Pokhara inspires artists.
- Site is a very peaceful area surrounded by Phewa Lake and greenery nearby.
- Provide a platform for the national and international.
- One and only PSM Art Gallery of Pokhara got demolished.

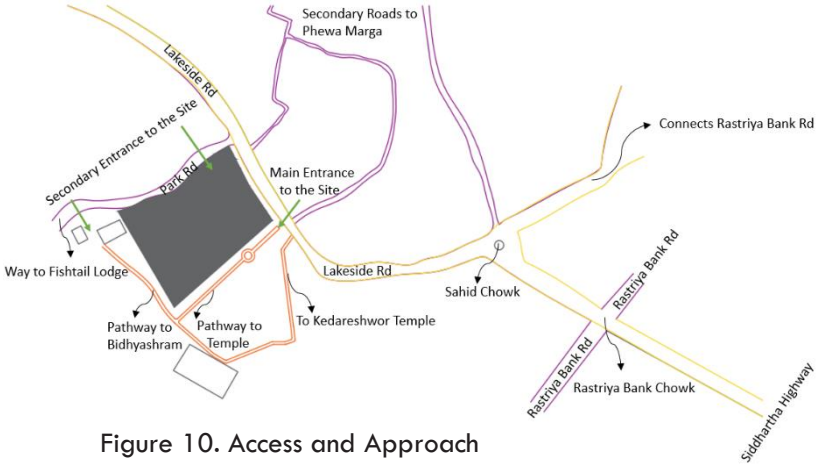


Figure 10. Access and Approach

3.4. Activities on Site

Figure 11. Morning

Figure 12. Daytime

Figure 13. Evening

- Morning: Peaceful walk in the gentle sunrise, connecting with nature.
- Daytime: A vibrant playground for all, laughter and camaraderie, appealing to diverse interests and ages.
- Afternoon: Groups gather under tall trees, fostering community through conversations and refreshments.
- Evening: Strategic location for solace and reflection, enhancing the experience with a beautiful view.

Design goals: Enhance current activities, preserve social and cultural values, and maintain the flow.

4. Conceptual Development

4.1 Approach guided by Site

Figure 14. View

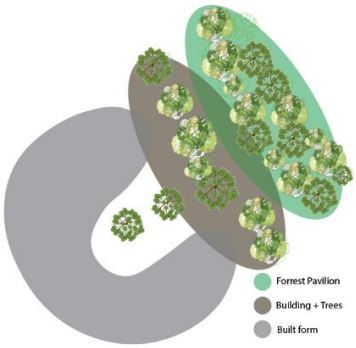
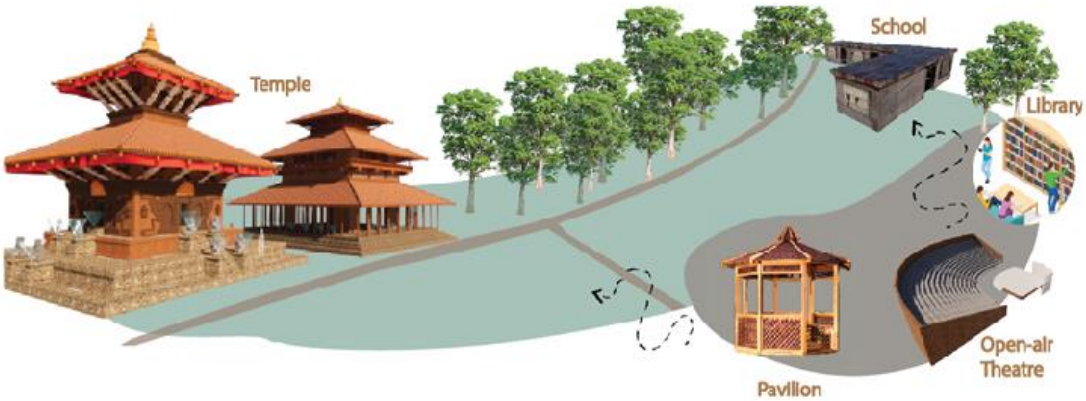


Figure 15. Trees Transition

Transition of existing trees provide elevation concept



Providing proper platform for existing structures (temple, school) like pavilion, open-air theatre and library. It supports ongoing activities.

Initial Development

Open floor Art Gallery for larger sculpture display at one side and can be viewed from the first floor is one of the idea for Art Gallery. Inspirational space for creativity in touch with nature (water, tree) is a must for visitors and artists in Art Center. Circular walkway initiation as in temporary display gallery is planned.

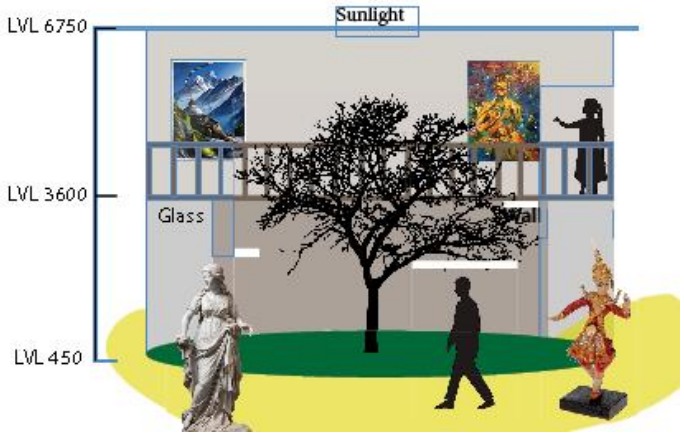


Figure 17. Art Gallery Initial

Figure 18. Walkway Gallery

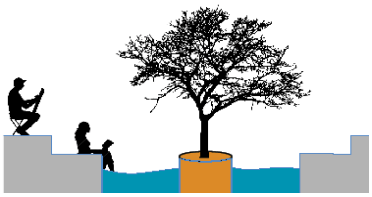


Figure 19. Inspirational Space

4.2 Approach by Foreground Background concept

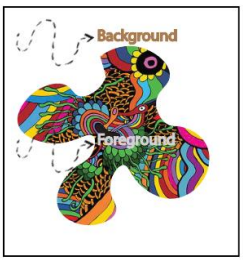


Figure 20. Foreground Background

Foreground:	Background:
Visually Dominant	Behind the main
Essence-Vibrant	Less Detail
Captures Attention	Neutral Foundation

Visualization:
The background holds the subjective core importance because background enhances and define the foreground. So, Background is the primary focus.

Interpretation:
Background ⟶ Building Mass ⟶ Neutral ⟶ White

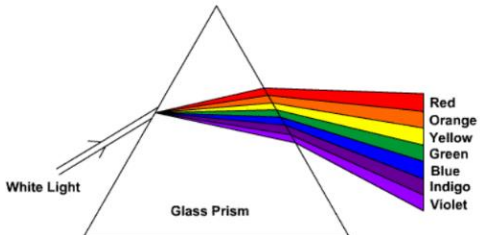


Figure 21. Inspirational Space

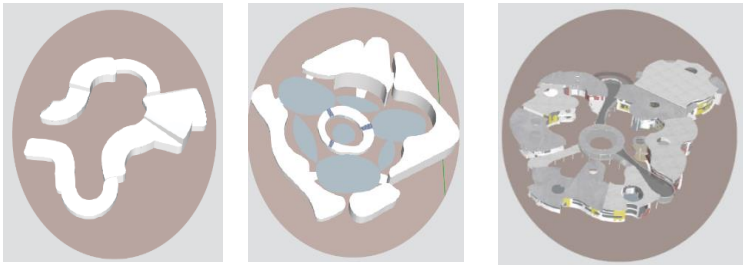
Mixture of all colors in a glass prism results WHITE. So, White color is the primary color and in our design building is the primary focus so, majority of the building mass is made in a neutral white look.

Foreground → Void → Communal space

Using primary colors RYB as a representation of all color where color also represent meaning.

Milind Mulick's Watercolor theory is one of the supporting theory to this design. Interplay between psychedelic colors and no colors are expressed in his arts where due to the white plain background, activity outside the building is more focused. Following his theory, design is created.

Form Development



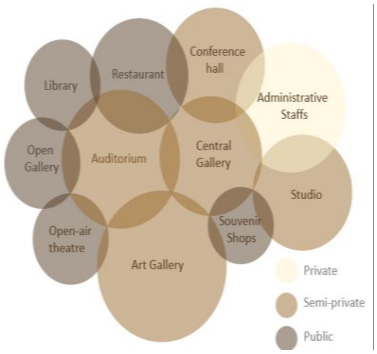


Figure 22. Zoning

Plan Development

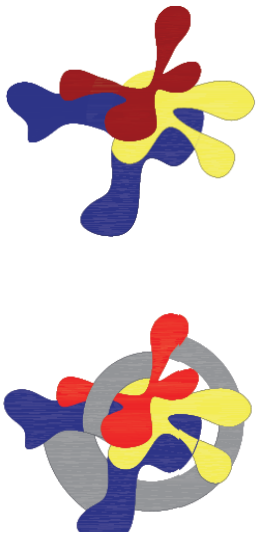
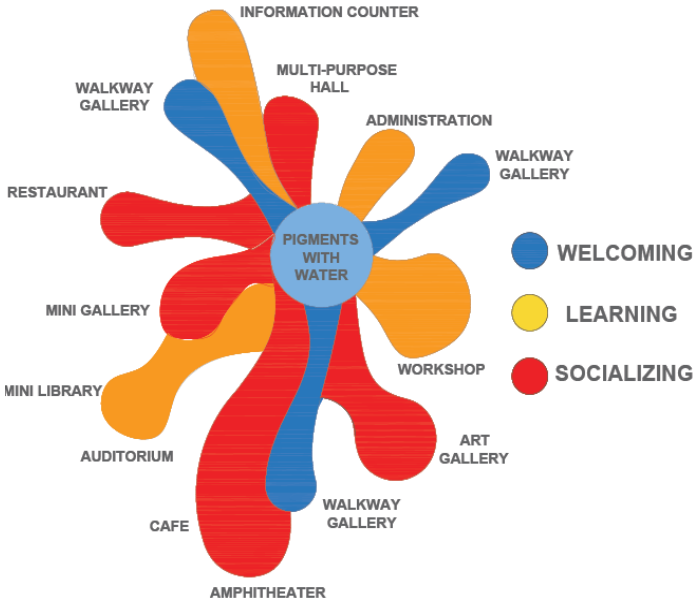


Figure 23. Splatter coloring technique



Red color represent socializing space (Restaurant, Art Gallery, Open-air theatre, Mini Gallery), Yellow color represent learning space (Information center, Admin, Workshop, Auditorium), Blue color represent Welcoming space (Walkway Gallery).

5. Masterplan

Figure 24. Masterplan

Being a public area, access from three side is provided. Entrance is welcomed by the walkway gallery that leads the way towards Auditorium or Art gallery / Workshop. Restaurant is provided near parking area as well as near main road so that it will be easy to people passing there only for food. Also, considering to the people in restaurant makes the project more sustainable. Small Café is provided from bifurcated staircase where view of lake is observed.

Art gallery consist of light gallery and dark gallery that provides both type of gallery and arts are displaced. This block consist of workshop on the ground floor and Artist residency on the first floor. Medical room is provided near the workshop for emergency. Amphitheater is used to run different programs like open exhibition, study, performance etc. Stage of amphitheater get shade from the first floor bridge of café for lakeside view. Service block is provided for the HVAC, generator and electrical room along with the guard room.

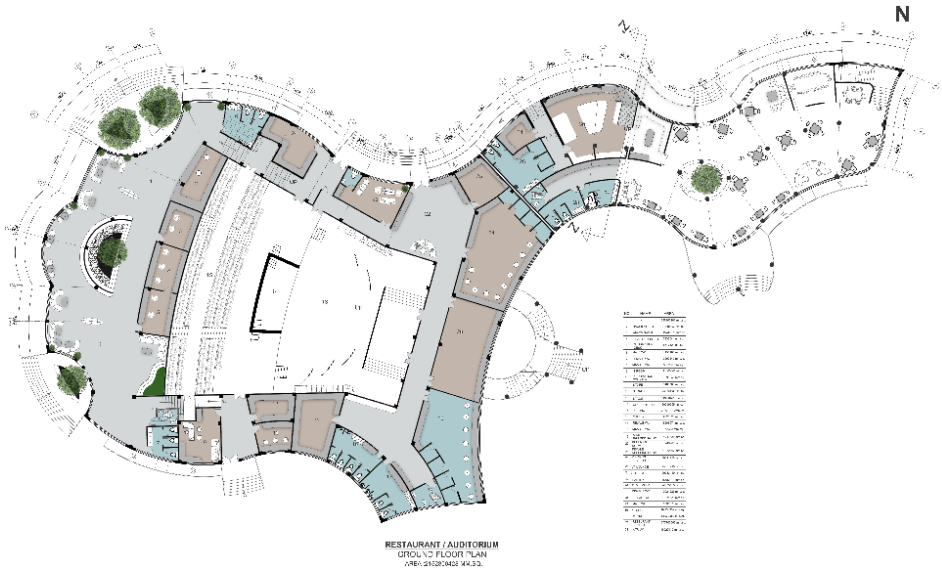
Figure 25. Walkway Gallery

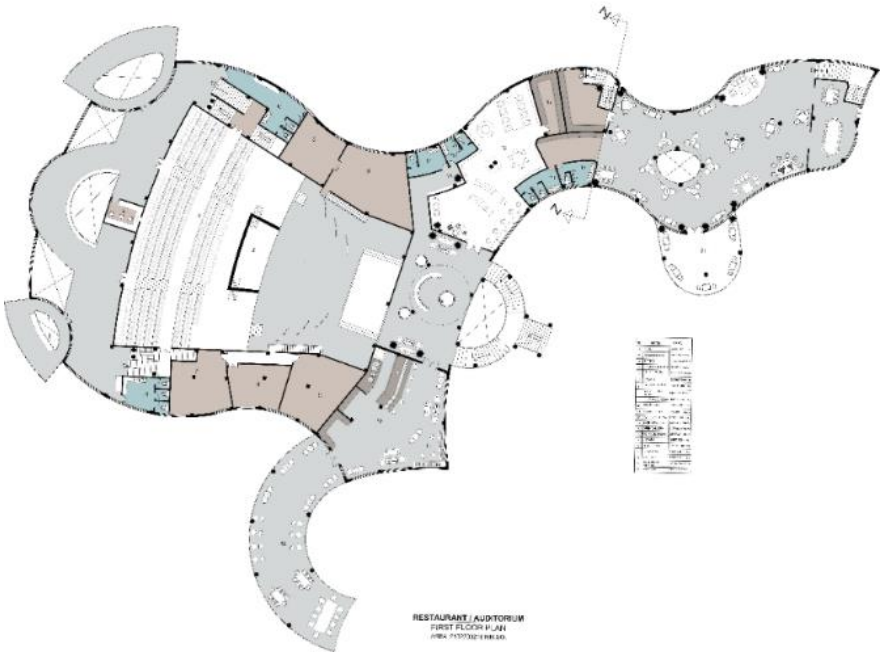
Figure 26. Workshp Area

Figure 27. Cafe/Library Entrance

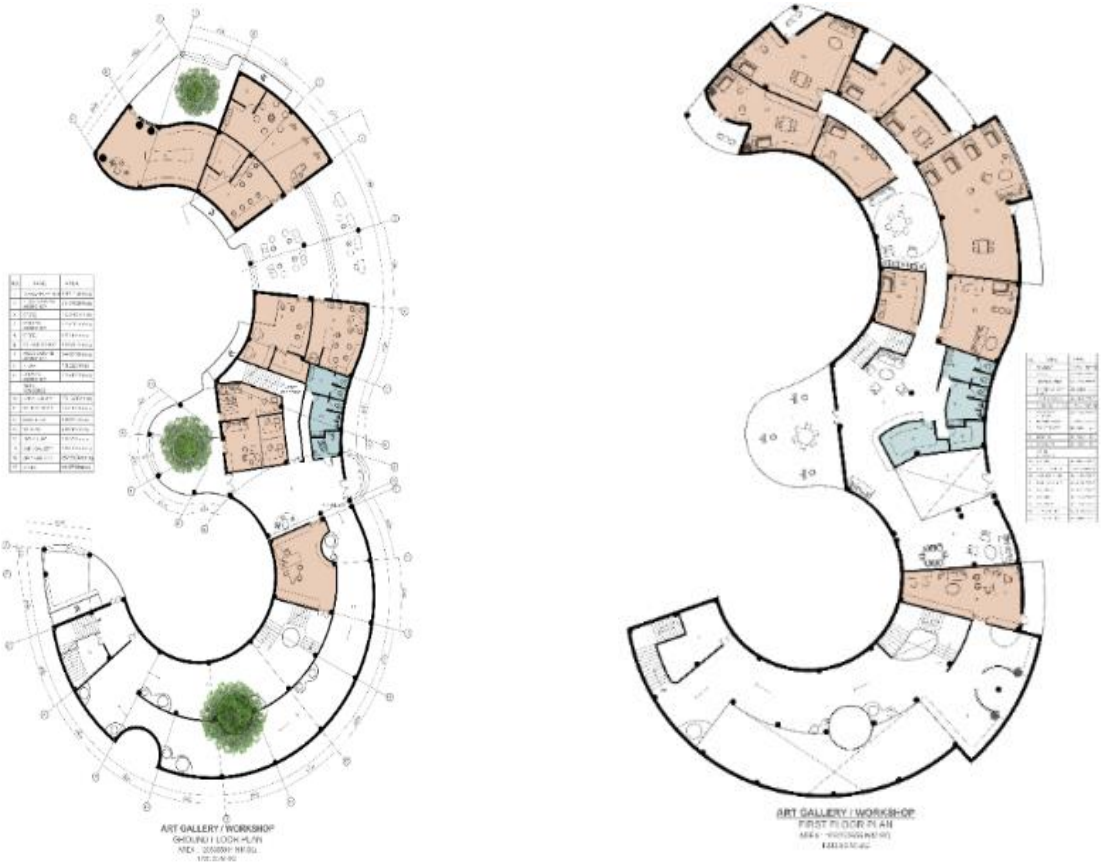
Administration block consist of multipurpose hall and conference hall for programs like literature festival, or small meetings. Three information counter for the public are provide in the three corner of the center.

Parking area consist of Bikes, Cars and a bus parking area. It has two waiting area where people rest. The forest pavilion is present at the front side of the site. It consist of existing trees and in between the trees are pavilion that provide a place for the artist for an inspiration or for the people as shade.

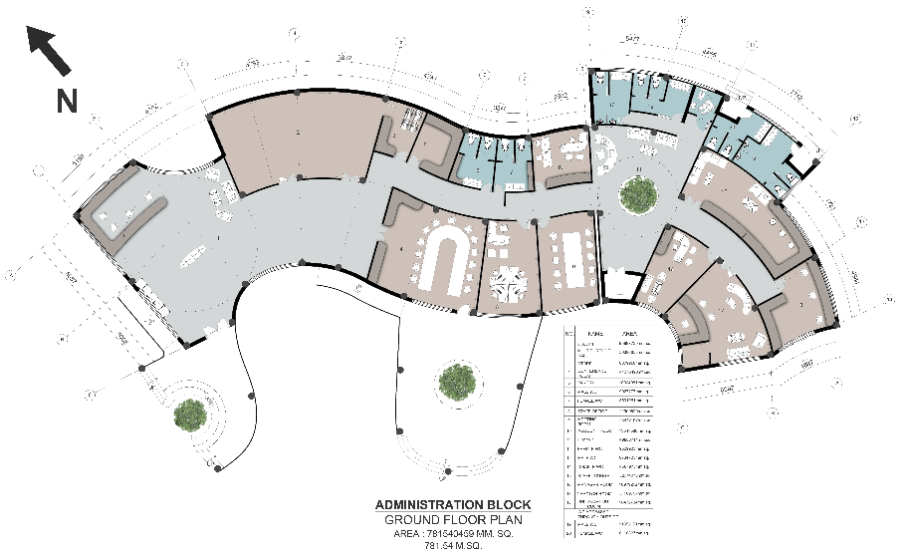




Restaurant has 2 entries which is placed near secondary entrance. Auditorium block consist of lobby with information counter, ticket counter, cloak room and snack counter. Auditorium hall entrance is provided through the first floor with seating capacity 300 with VIP seats.

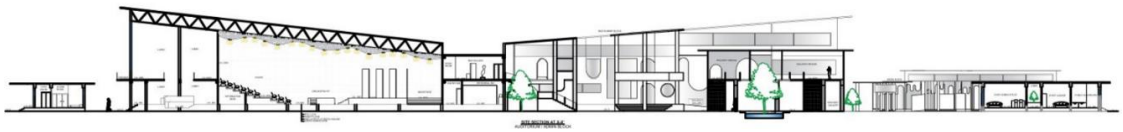


Art gallery and Workshop is placed near the main walkway from where people are easily attracted towards it. Workshop area consist of painting, wood carving, stone carving, and ceramic making. Art gallery consist of dark gallery and light gallery.



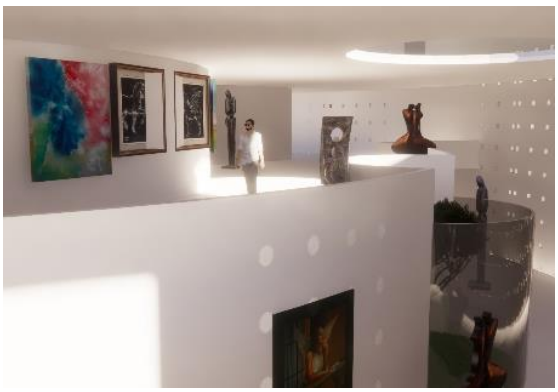
Administration block consists of information counter, Multi-purpose hall, Conference hall, and Staff rooms.

Due to the splatter coloring technique, building are somewhere splattered by its represented color.



Site section is drawn from the longest angle showing auditorium hall, central gallery and administration block. Elevation of restaurant block is also viewed.

Spiritual Pavilion



Art Gallery

Mini Gallery

Cultural Display

6. Conclusion

In conclusion, the design and planning process for the Art Center in Komagane Park, Pokhara, reflects a meticulous and holistic approach to creating a space that aligns with the site's unique attributes and fulfills the specific requirements outlined for an art-focused facility.

In summary, the Art Center is poised to become a vibrant and inclusive landmark in Pokhara, Nepal, embodying the ideals of art, culture, and community engagement. Its thoughtful design and alignment with the site's characteristics promise a space that will inspire, educate, and captivate visitors for years to come.

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Pokhara Engineering College (PEC)
Phirke, Pokhara-8, Kaski, Nepal
PO Box: 540, Tel: 977-61-581209/578530
E-mail: info@pec.edu.np.
www.pec.edu.np