"Architectural and Structural design of a rural Bus Stand in Himachal Pradesh"

A PROJECT

Submitted in complete fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

Mr. Chandra Pal Gautam (Assistant Professor)

By

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To

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT, SOLAN – 173234

HIMACHAL PRADESH, INDIA

MAY 2017

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Architectural and Structural design of a rural Bus Stand in Himachal Pradesh"** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Udit Sharma (131218) during a period from January 2017 to May 2017 under the supervision of **Mr. Chandra Pal Gautam** Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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Acknowledgement

In Performing my project, I had to take the help and guideline of some respected persons, who deserve my gratitude. The completion of this project report gives me much Pleasure.

I would like to show my gratitude to Asst. Prof. Mr. Chandra Pal Gautam , for giving me a good guideline for project throughout numerous consultations. I would also like to expand our Deepest gratitude to all those who have directly and indirectly guided me in writing this report. I also thank Dr. Ashok Kumar Gupta , Professor and Head of Department , for taking this project to Himachal Government.

Many People, especially our classmate and friends, have made valuable comment suggestions on the project which gave me an inspiration to improve my project. I thank all the people for their help directly and indirectly to complete my project.

Udit Sharma (131218)

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Abstract

Bus-terminal is an essential component of urban transport facilities which defines the beginning (origin) or end (terminating) of the line for the transportation system. It normally requires a size-able land in a strategic part of an urban area. A well planned or managed bus-terminal will act as catalyst to the social and economic development of the surrounding areas. On the other hand, bus-terminal is an asset to an area as it may act as catalyst to economic and social development of the surrounding areas. However, poorly planned and sited terminal for buses may generate traffic problems as well as deteriorating the quality of life of the affected surroundings. As with engineering and operational aspects of terminal facilities the focus would be on the design to fulfill traffic capacity requirement and operational efficiency to operators and passengers. This report investigates the Architectural and Structural design of a rural Bus Stand in Kothkhai, Shimla.

Keywords: Revit Architecture, 3ds max, Truss, Dead Loads

CHAPTER 1: INTRODUCTION

1.1 General

A bus terminus is a designated place where a bus or coach starts or ends its scheduled route. The terminus is the designated place that a timetable is timed from. Termini can be located at bus stations, interchanges, bus garages or simple bus stops. [1]

According to surveys most of the rural bus stands are poorly planned and constructed for example in terms of waiting area, mostly it is not strategic because the plan at bus-terminal not suitable for the users and customers, Public facilities such as toilets, telephone are inadequate, Lack of facilities for staff such as office and control room, storage of personal belongings, rest room, toilets and so on.

1.2 Comparison between flat area bus stand and hilly area bus stand

It is not always the same design for flat area bus stand and hilly area bus stand the terminal design is different for each of them. Following are the comparison of flat area bus stand and hilly area bus stand.

flat area bus stand	hilly area bus stand
Less earthquake prone area	More earthquake prone area
Less wind load, no snow load	High wind load and snow load is also there
More amount of area	Less amount of area so we have to go for more levels
Affect of temperature(high temp.)	Affect of temperature(low temp.)

Table 1.1 Difference between flat and hilly area bus stand

1.3 Current scenario in Infrastructure of Public Buildings

Most of the bus stand being propagated in rural areas are urban-based and biased. They trickle down to rural areas. Rural population is not composed of subhuman beings. Their needs and aspirations are similar to those living in urban areas. Bus stand development should take place keeping these aspirations in view.

Inadequate space at some urban Integrated Bus Terminus cause frequent congestion at the premises and hence there is need for setting up of rural bus terminals in Kothkhai, Shimla.

1.4 Indian Provisions on Public Buildings

1.4.1 Licensing Authority

The National Transport Authority ("Authority") is the statutory body for licensing public transport services in the State, under the provisions of the Public Transport Regulation Act, 2009. (The Authority is also the procurer/contracting agency for Public Service Obligation "PSO" public bus services nationwide, including some in rural areas). Under the 2009 Act, the Authority has to consider a variety of matters in determining whether or not to issue a licence. Section 10 (b) obliges inter alia that the Authority take into account the following:

1. "The need to provide a well-functioning, attractive, competitive, integrated and safe public transport system of services and networks for all users,
2. The need for the preservation of good order and safety on public roads".

The Authority works closely with the road (local) authorities in its deliberations. [2]

1.4.2 Direction by Road Authority

The local authority as the competent road authority has an important role in relation to the location of bus stops under Section 85 of the Road Traffic Act, 1961 as amended by Section 16 of the Road Traffic Act, 2002. [2]

1.4.3 Amending or Revoking a Bus Stop

Please note also that Section 16 of the 2002 Road Traffic Act includes the following:

Directions under section 85 of the Principal Act in force immediately before the commencement of this section shall continue in force after such commencement as if given under section 85 (as inserted by this Act) of the Principal Act and may be amended or revoked accordingly.

Under this provision, road authorities can revoke or amend (relocate) bus stops, restrict the picking up and/or the setting down of passengers or the standing of buses at any previously approved stop location, should said authorities identify a need to do so.

transparency. It is recommended that road authorities formalise the process of obtaining the However, it is important that the process behind such decisions provide clarity and required information (e.g. application form including exact information about the location of the proposed stop, the intended usage of said stop, whether the stop is for pick up or set down and if standing is allowed, for how long).

It is also recommended that road authorities formalise the notifications regarding decisions they may take. A local/road authority can amend a bus stop permission at any time by sending a written notice to the relevant operator. However, in reaching a decision, it is recommended that the road authority actively engages with the bus operator to discuss issues problems with bus stop locations, seeks to find mutually acceptable solutions in a fair and transparent decision-making process where possible, and ensures the implementation of the decision made.

All such formal notifications should also be sent to the Authority at: **stop.approval@nationaltransport.ie**.so that it can amend any effected public bus passenger service licence to reflect the change.

1.5 Location of a rural bus stand

1.5.1 Close to Passenger Origin/Destination

An effective public transport system needs stopping locations that are convenient for passengers, both in terms of journey origins and journey destinations. The selection of bus stop locations that reduce walking times from origins and to final destinations should improve the attractiveness of public transport and contribute to the achievement of national, regional and

local transport policy objectives. [2]

Locating stops in positions that do not provide an appropriate level of proximity for passengers may mean that some potential passengers will not use the service. (Potentially this loss of patronage could be the difference between retention and loss of the particular route). In this regard, as a general approach, road authorities should consider the retention of existing stops insofar as possible, as these probably already meet an expressed demand from customers. (In some cases, this may require mitigation measures to address specific issues or concerns).

The timetabled bus frequency and associated passenger activity should be considered this guidance is intended for standard bus stops in general. While the guidance will be helpful, the assessment of high-frequency or multi-route shared stops, (where it is likely that buses will be standing for a period, or passengers may be waiting for an extended time) will require site specific detailed consideration.

1.5.2 Accessible Location - Junctions

The location of the particular bus stop has to be accessible to intending passengers, and as convenient as possible.

In general, bus stops should not be located at some distance along roads bound with fences or blank walls—these locations are inconvenient to all passengers residing away from the main road.

For instance, if the bus stop on a main road is intended to serve the residents of a particular townland, estate or conclave of houses, it is important that the bus stop should be located close to where these residents access the main road.

In effect, it should be expected that bus stops would be located proximate to junctions, as opposed to being positioned at a significant remove.

The preferable location of a bus stop is on the exit side from a junction, for the following reasons that the junction itself and any crossing/turning movements will remain clear to approaching traffic, and will not be obstructed by a stopped bus; and Drivers will be expecting to slow on approach to a junction, and this offers the most forgiving (slower) speed regime for traffic approaching buses that are stopped on the far side of the junction.

1.6 Objectives of the Project

This project has following main objectives:

Conducting research on the existing bus terminal of a city and proposing a new model of bus terminal according to findings

1. Architectural planning of whole bus-terminal
2. Structural design of complete bus-terminal

1.7 Scope of the Project

Bus-terminal is an asset to an area as it may act as catalyst to economic and social development of the surrounding areas. However, poorly planned and sited terminal for buses may generate traffic problems as well as deteriorating the quality of life of the affected surroundings. This project focuses mainly the structural design of whole bus terminal. As with engineering and operational aspects of terminal facilities the focus would be on the design to fulfil traffic capacity requirement and operational efficiency to operators and passengers. The proposed far side terminating bas terminal model which located outside city centre may have added advantages such as reducing unnecessary congestion and improving the environment.

Chapter 2: Literature Review

2.1 Introduction

This chapter provides an overview of previous research on knowledge sharing and intranets. It introduces the baseline about bus stand design that comprises the main focus of the research described in this report.

In order to do research, the understanding of the topic should be first. To understand the topic several types of gathering information had been done through literature study that related to the topic. There were various references such as books, journals, IS codes, Internet, and magazines being used as a literature study in this report.

1**. Mr. K. Kailashnathan (Chairman, Steering Committee), (Chairman, Ahmedabad Urban Development Authority (AUDA))** published working papers on Ahmedabad Bus rapid transit system in December 2005.

CONCLUSIONS

These papers were presented by GIDB in the collaboration with AMC and AUDA and published by Centre for Environmental Planning & Technology University, Ahmedabad. From these papers, I took the baseline for my project that what should I have to do for proper architectural design.

2**. Naresh Kuruba (Research Intern – Urban Transport EMBARQ India)** published a paper in 2009 on A Methodology to Incorporate Infrastructure into Public Transport Planning in Constrained Urban Areas.

CONCLUSIONS

For the operator, the implementing terminals results savings in vehicle kilometres travelled (VKT) for existing services. For a passenger, an additional terminal can improve service reliability and frequency through the introduction of shorter routes. The study is recommended to improve the quality of transfer/interchange facilities. There is a need to plan, design and identify the impact of proposed terminals to maximize the operational efficiency.

3**. MD Anamul Hasan (Student of civil engineering in SRM university Chennai)** submitted a project report on Structural Design of a Bus Terminal in January 2006.

CONCLUSIONS

The project report of Mr. MD Anamul Hasan explains me about how to design the roof trusses.I also learned about dead load calculations from his report. His project report is based on poorly planned and constructed bus-terminal named "Mania Bus-terminal" which is located in one of the city of Rajasthan, Dholpur. [3]

4**. IRC : 80-1981** (TYPE DESIGNS FOR PICK-UP BUS STOPS ON RURAL (i.e. NON-URBAN) HIGHWAYS)

CHAPTER 3: MATERIALS AND METHODOLOGY

3.1 Software requirements

3.1.1 AUTODESK Revit architecture 2014

Revit Architecture is a software which works on BIM(building information module) that has quickly emerged as the forerunner in the design industry. Revit Architecture is as much a change in workflow (if you come from a 2D or CAD environment) as it is a change in software.

I have used this software for my architectural planning, all of my plans elevations and other drawing are made in Revit Architecture 2014.

3.2.2 AUTODESK 3ds max

Autodesk 3ds Max, formerly 3D Studio, then 3D Studio Max is a professional 3D computer Application for making 3D animations, models, games and images. It is developed and produced by Autodesk Media and Entertainment. [4] It has modelling capabilities, a flexible plugin architecture and can be used on the Microsoft Windows platform. It is frequently used by video game developers, many TV commercial studios and architectural visualization studios. It is also used for movie effects and movie pre-visualization. To its modelling and animation tools, the latest version of 3ds Max also features shaders (such as ambient occlusion and subsurface scattering), dynamic simulation, particle systems, normal map creation and rendering, global illumination, a customizable user interface, new icons, and its own scripting language. [5]

I have used this software for rendering and animation for my architecture plans and drawings.

3.3.3 STAAD.pro

STAAD or (STAAD.Pro) is a structural analysis and design computer program originally developed by Research Engineers International at Yorba Linda, CA in 1997. In late 2005, Research Engineers International was bought by Bentley Systems. [6]

I have used this software for my truss design.

Some other software are also used for small works in the making of this project.

1. MS office excel for analysis

2. Autocad2012(2D and 3D) for drawing

3. Photoshop, Paint, Snipping tool (for figures and pictures)

3.2 Methodology

3.2.1 Site

Site is decided by Himachal government in Kothkhai, Shimla. As Kothkhai pubilc is suffering from transport problems from many years the government decided to make a bus stand in Kothkhai of capacity of 3 bus stand.

3.2.2 Requirements of Bus stand

The requirements of a rural bus stand which are given to me by Himachal Pradesh are following.

S No.	Facilities	Minimum Total requirement
1	Bus Bays	4
2	Rest Room for running crew and other HPBSMDA staff with toilet and bath	25 m^2
3	Drinking water with purifier and cooler	1
4	shops	Minimum 9m^2
5	Length	20-25 m
6	Area	200m^2

Table 3.1 Requirements of a rural Bus stand

3.2.3 Architectural Work

Architectural drawing of bus stand are made like plans, elevations, 3d drawings, 2d drawings by using the AUTODESK Revit Architecture 2014 according to requirements. All the drawings sheets had shown to Himachal Government and approved.

3.2.5 Structure Design

After architectural design, dead and wind loads were calculated for our building and then according to loads truss, beams, columns, foundations were designed.

CHAPTER 4: ARCHITECTURAL DRWAINGS AND DESIGN CALCULATION

4.1 ARCHITECTURAL DRWAINGS

4.1.1 Plan

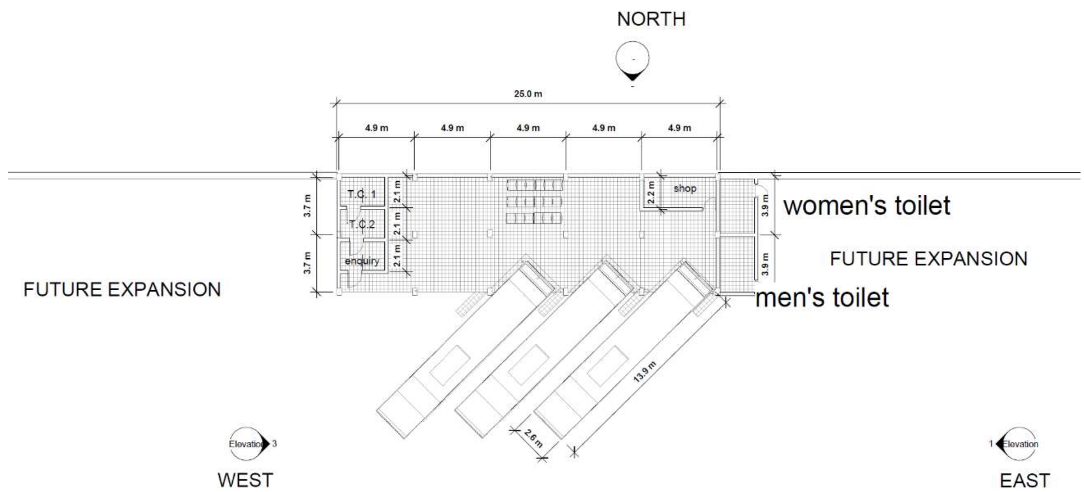


Figure 4.1 Plan of bus stand

4.1.2 Elevations

Figure 4.2 Elevations of bus stand

4.1.3 3d drawings

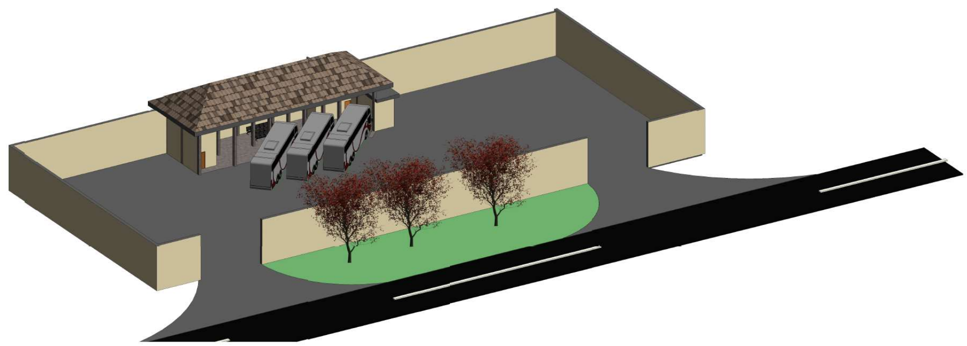


Figure 4.3 3d drawing of bus stand

4.1.4 Rendered 3d drawings

Figure 4.4 Rendered 3d of bus stand

4.2 Dead Loads

Load imposed by the stable parts of structure which causes stresses into the structure is called dead load, It consists weight of materials used in the building, these material can comes under dead load definition only when they achieve their permanent position in the structure. Dead load applied to the structure for a long period of time

Load applied for short duration is not considered in dead load such as wind load, earthquake load, vibration etc. Beams, columns, floor, roof, wall, doors, windows, plasters, electric trays pipes, ventilation systems etc. all these permanent parts of structure are considered as dead load.

All types of dead load applied stresses to the structure, this stress can be of tension or compression type. Due to these stresses deformation or displacement occur, to design structure we have to check for these deformations should be in the permissible limit.

For computation of dead load we have to know the unit weight of the material for which we are calculating the dead load, by multiplying the unit weight of material to the volume of the member we can calculate dead load of the member and after calculating dead load for all members of the structure, we can find complete dead load of the structure by add all members dead load calculated individually

Dead load = volume of member X unit weight of materials

Some of the members' unit weights are given in the table

4.2.1 Calculation of roof dead load

Firstly, the projection of the roof

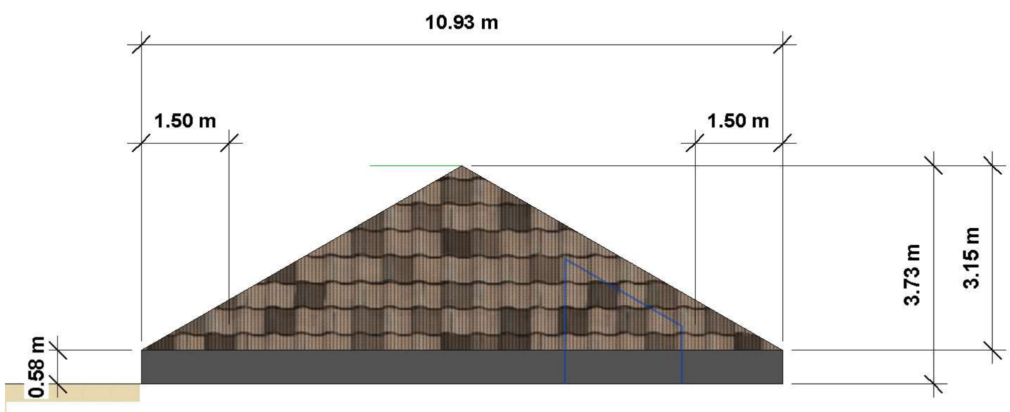


Figure 4.5 Projection of roof (first)

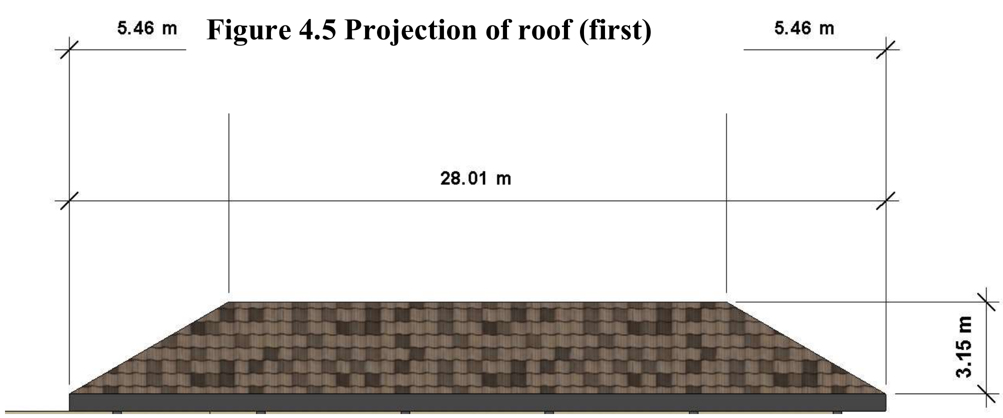


Figure 4.6 Projection of roof (second)

Now, we have to find the area of both projection in the first drawing there is a simple triangle so we can find area of projection easily but in the second drawing we have to split in two triangle and one rectangle.

The area of first projection

= 2 x (.5 x (10.93 x .5) x 3.15

= 17.2 m^2

The area of second projection

=2 x (.5 x 5.46 x 3.15) + 17.09 x 3.15

= 17.1 +53.8

= 71 m^2

Total area of both projection

= 17.2 + 71

= 88.2 m^2

In the main building we have 2 units of both the projections

Total roof area would be:

= 2 x 88.2

= 176.4 m^2

Dead load calculation of different type of TATA Shakti roof sheets

Thickness (mm) of roof sheet	Approximate Weight (kg) m2	Area(m2)	weight(total)(kg)	Factor of Safety	dead load for designing
0.3	2.25	176.4	396.9	1.5	595.35
0.35	2.65	176.4	467.46	1.5	701.19
0.4	3	176.4	529.2	1.5	793.8
0.45	3.4	176.4	599.76	1.5	899.64
0.5	3.8	176.4	670.32	1.5	1005.48
0.55	4.2	176.4	740.88	1.5	1111.32
0.6	4.55	176.4	802.62	1.5	1203.93
0.63	4.8	176.4	846.72	1.5	1270.08
0.8	6.1	176.4	1076.04	1.5	1614.06
1	7.45	176.4	1314.18	1.5	1971.27
1.25	9.25	176.4	1631.7	1.5	2447.55

Table 4.1 Dead load calculation of different type of TATA Shakti roof sheets

4.3 Wind Load

The force on a structure arising from the impact of wind on it.

As we are making this bus stand in Shimla so we take the basic wind speed of Shimla according to IS 875 part 3 1983 (Appendix A clause 5.2) as 39 m/sec.

Design wind speed is given by

$V_z = V_b K_1 K_2 K_3$

Where

V_z = design wind speed at any height z in m/sec.

V_b = basic wind speed.

K_1 = probability factor (risk coefficient). = 1.05 (see clause 5.3.1 IS 875 p-3 1983)

K_2 = terrain height and structure size factor. =1.0 (see clause 5.3.2 IS 875 p-3 1983)

K_3 = topography factor. = 1.0 (see clause 5.3.3 IS 875 p-3 1983)

$V_z = 39 \times 1.05 \times 1.0 \times 1.0 = 40.95$ m/sec

$P_z = 0.6 (V_z)^2 = 0.6 \times 1676.90 = 1006.14$ N/m^2

Wind force is equal to

$(Cp_e - Cp_i) \times A \times P_z$

Wind angle	Pressure Coefficient		Cp_i	Cpe ± Cpi		$A(m^2)$	$(Cp_e \pm Cp_i) \times A$		P_z	$F(N/m^2)$	
	Wind	Lee		Wind	Lee		Wind	Lee		Wind	Lee
0'	0.0133	-0.8	-0.7	-0.686	-1.5	9.854	-6.76	-14.78	1006.14	-6801.349442	-14871.7553
			0.7	0.713	-0.1	9.854	7.0259	-0.985	1006.14	7069.041038	-991.450356
90'			-0.7	-1.5	-1.5	9.854	-14.78	-14.78	1006.14	-14871.75534	-14871.7553
	-0.8	-0.8	0.7	-0.1	-0.1	9.854	-0.985	-0.985	1006.14	-991.450356	-991.450356

Table 4.2 Wind Load Calculation

As 14.871 kN is maximum wind load so we take the wind load is equal to 14.871kN.

4.4 Design of Roof Truss

In old days' roof build is executed on site where carpenter fix the wall plates to make the structure and then cut the rafters to the required length. In old time, it was acceptable yet it was quite complex because it involves human measurements.

But, now a days prefabricated roof trusses have replaced old method which involves roof carpentry. Now we can lift and crane trusses easily and quickly. We can make trusses according to requirements and thus serve as a simplified way of roofing. Steel roof truss is most commonly used all over the world.

We use steel truss for build the strong base. They are used for both buildings and bridges. Roof truss design should follow the general layout that is prepared first, and then the external load is to be estimated including the self-weight of truss.

Different designs of roof trusses are prepared depending upon the structure shape. There are different types of trusses out there, for example-parallel, triangular and trapezoidal trusses. In deep roofs, we use parallel trusses whereas triangular trusses are used in the trusses with steep pitches.

We can say that in steel roof truss design cost of truss equal to twice the cost of purlins and the cost involving roof covering. Purlins are generally used for small roofs which are covered with steel roofing.

In aspect of economy, purlins are quite economic, their property of lightweight makes them easily fit between the steel structures. In the determining the strength of the structure gravity load plays an important role.

4.4.1 ROOF STRUCTURE

While determining that the truss roof will be the best choice for the roof it is essential to match the compatibility of the roof type with the truss. Truss does not support all kinds of roofs. Trusses are highly suitable for the roof types which are flat, saddle or single pitch. It is averagely suitable for a **hipped roof** as well. But it is not very compatible for pyramid roofs.

4.4.2 PRESSURE ANALYSIS:

The upper chord and the lower chord are under compression and tension. This state depends upon the inclination of the diagonals. It is required to manage the pressure on the roof by analyzing as extreme loading can change the sign of structure which will result in making the upper chord be under tension and the lower be under compression.

4.4.3 BUCKLING OF MEMBERS

The strength and stability are termed as members of the truss. Steel can handle the tensile forces in roof truss, but the compression members are to be taken well care of. Composite and stiffened compression members must be used so as to save them from buckling down.

4.4.4 MANAGING THE SYSTEM LINES

The system lines of the trusses should meet at the panel points. But it is difficult to achieve as all the stress is exerted on members and connectors. Therefore, either the system lines should meet at one point or the system lines of diagonals should meet at least within the chord member in a roof truss. This is to manage the load and ensure proper functioning.

4.4.5 Selection of A Truss

Selection criteria

Span depth ratio = l/8 to l/10

Truss spacing = ¼ to 1/5 of span length

We have a hipped roof so we have to design the truss according to hipped roof..

4.4.6 Truss and column pictures

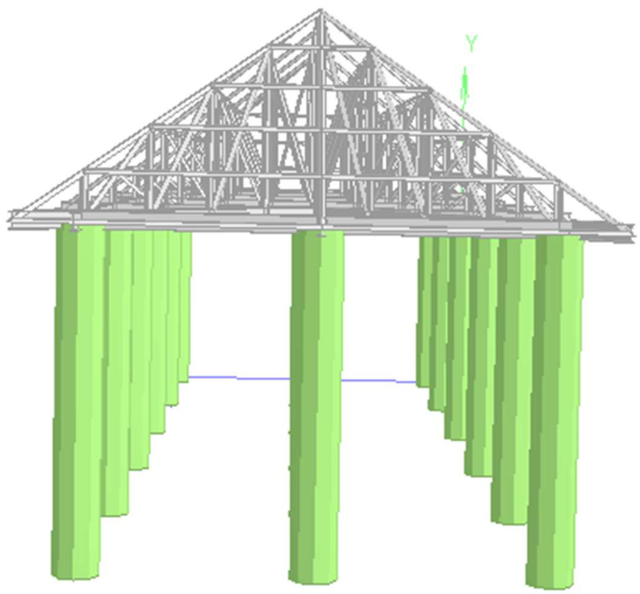


Figure 4.7 Side view of truss and columns

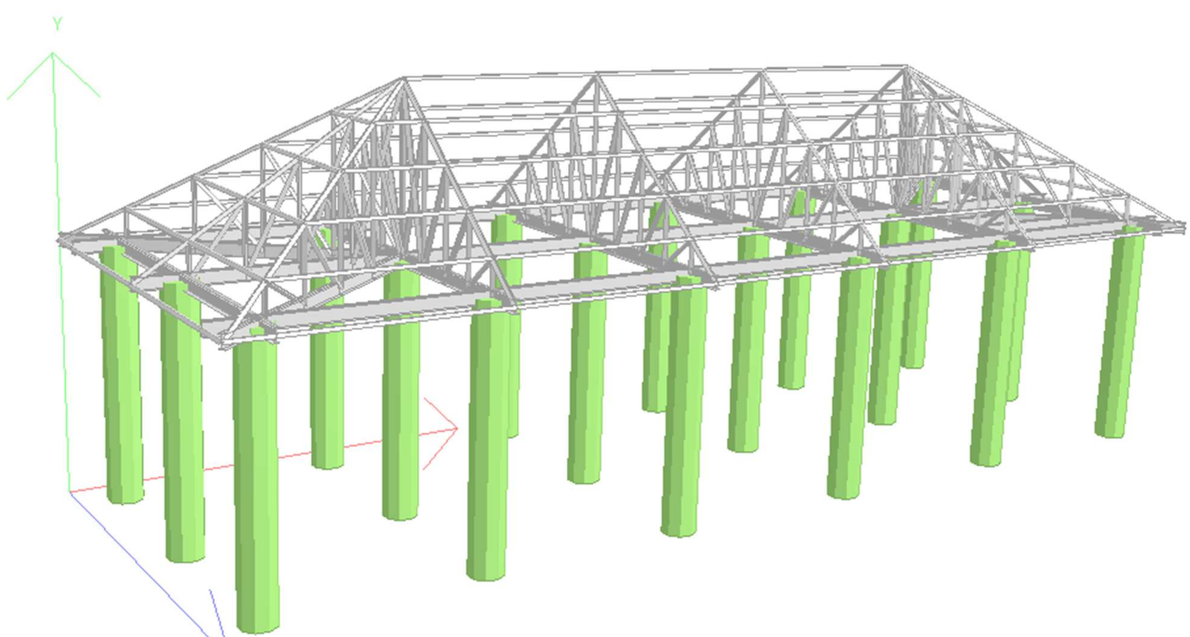


Figure 4.8 3D view of truss and columns

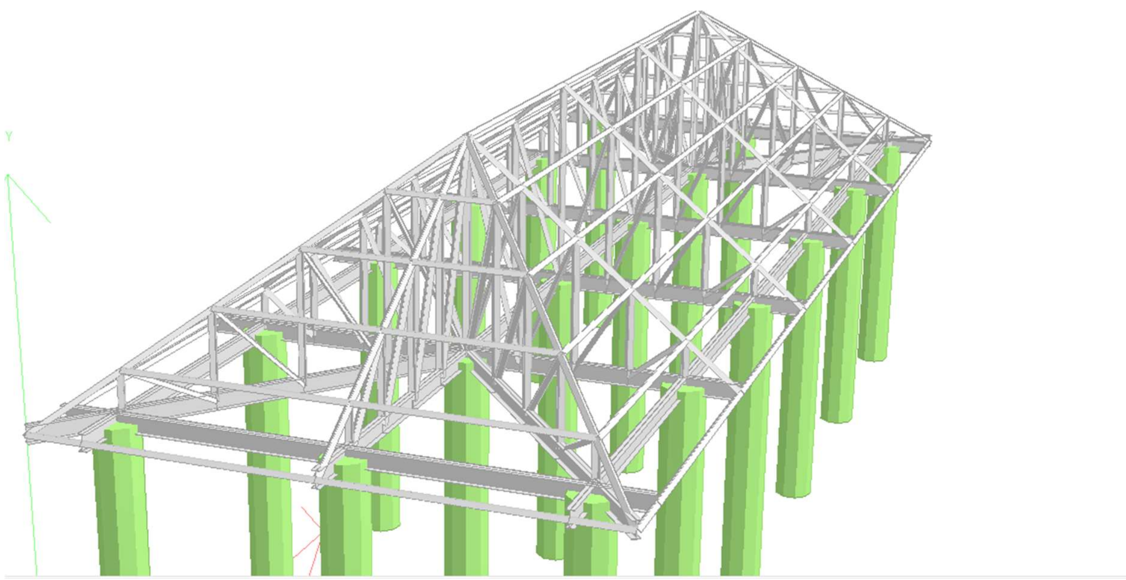


Figure 4.9 3D of truss and columns

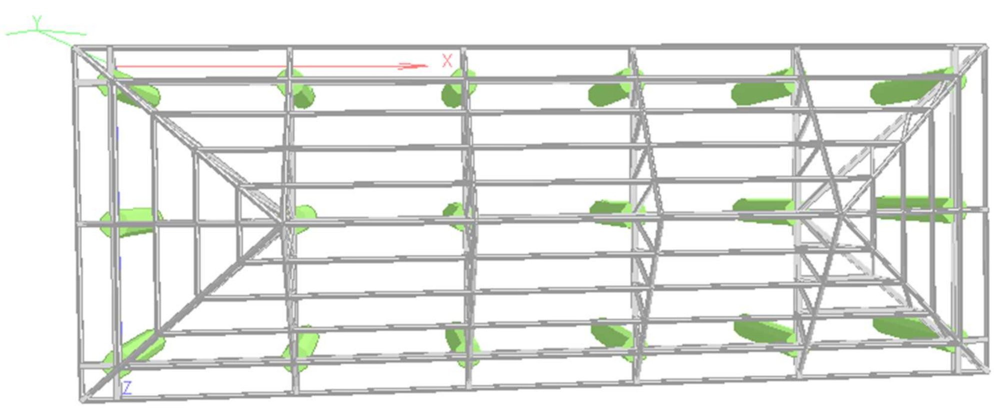


Figure 4.10 Top view of truss and columns

4.5 Designs and Results

4.5.1 Column design

Reinforced Concrete design

Length = 6000mm Fe 415 and M25

Column.	Cross Section Dia(mm)	Cover(mm)	Required Steel Area(sq.mm)	Main Reinfrocement	Tie Reinfoecement
1	800	40	1609.63	15,12 mm ø 1696.46 sq.mm.	8 mm ø @ 190 mm c/c
2	800	40	1009.3	9,12 mm ø 1017.88 sq.mm.	8 mm ø @ 190 mm c/c
3	800	40	1009.3	9,12 mm ø 1017.88 sq.mm.	8 mm ø @ 190 mm c/c
4	800	40	1040.22	10,12 mm ø 1130.97 sq.mm.	8 mm ø @ 190 mm c/c
5	800	40	9650.97	48,16 mm ø 9650.97 sq.mm.	8 mm ø @ 190 mm c/c
6	800	40	1221.69	11,12 mm ø 1244.07 sq.mm.	8 mm ø @ 190 mm c/c
7	800	40	1221.69	11,12 mm ø 1244.07 sq.mm.	8 mm ø @ 190 mm c/c
8	800	40	10455.22	52,16 mm ø 10455.22 sq.mm.	8 mm ø @ 190 mm c/c
9	800	40	52.69	8,12 mm ø 904.78 sq.mm.	8 mm ø @ 190 mm c/c
10	800	40	52.23	8,12 mm ø 904.78 sq.mm.	8 mm ø @ 190 mm c/c
11	800	40	1009.3	9,12 mm ø 1017.88 sq.mm.	8 mm ø @ 190 mm c/c
12	800	40	1009.3	9,12 mm ø 1017.88 sq.mm.	8 mm ø @ 190 mm c/c
13	800	40	1829.46	17,12 mm ø 1922.65 sq.mm.	8 mm ø @ 190 mm c/c
14	800	40	53.78	8,12 mm ø 904.78 sq.mm.	8 mm ø @ 190 mm c/c
15	800	40	50.98	8,12 mm ø 904.78 sq.mm.	8 mm ø @ 190 mm c/c
16	800	40	53.62	8,12 mm ø 904.78 sq.mm.	8 mm ø @ 190 mm c/c
17	800	40	1609.63	15,12 mm ø 1696.46 sq.mm.	8 mm ø @ 190 mm c/c
18	800	40	52.69	8,12 mm ø 904.78 sq.mm.	8 mm ø @ 190 mm c/c

Table 4.3 Reinforced Concrete design of Columns

4.5.2 Foundation Design

A foundation (or, more commonly, base) is the element of a structure which connects it to the ground, and transfers loads from the structure to the ground. Foundations are generally considered either shallow or deep.

We are taking a isolated footing in our case since our location of the bus stand is in Himachal Pradesh (hilly region).

Footing no.	Foundation Geometry		
	Length	Width	Thickness
1	4.25	4.25	1.203
2	2.75	2.75	0.801
3	2.15	2.15	0.802
4	2.65	2.65	0.801
5	2.15	2.15	0.802
6	2.15	2.15	0.802
7	2.65	2.65	0.801
8	2.15	2.15	0.802
9	2.15	2.15	0.802
10	4.15	4.15	1.203
11	1.8	1.8	0.802
12	1.8	1.8	0.802
13	2.65	2.65	0.802
14	1.8	1.8	0.802
15	1.8	1.8	0.802
16	1.8	1.8	0.802
17	2.65	2.65	0.801
18	1.8	1.8	0.802

Table 4.4. Dimensions of Foundation

Footing no.	Footing Reinforcement			
	Bottom Mz	Bottom Mx	Top Mz	Top Mx
1	Ø12 @ 55 mm c/c	Ø12 @ 65 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c
2	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c
3	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
4	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c
5	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
6	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
7	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c
8	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
9	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
10	Ø12 @ 60 mm c/c	Ø12 @ 65 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c
11	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
12	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
13	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c
14	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
15	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
16	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c
17	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c	Ø8 @ 50 mm c/c
18	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c	Ø10 @ 75 mm c/c

Table 4.5. Reinforcement of Foundation

4.5.2.1 Drawing of foundation

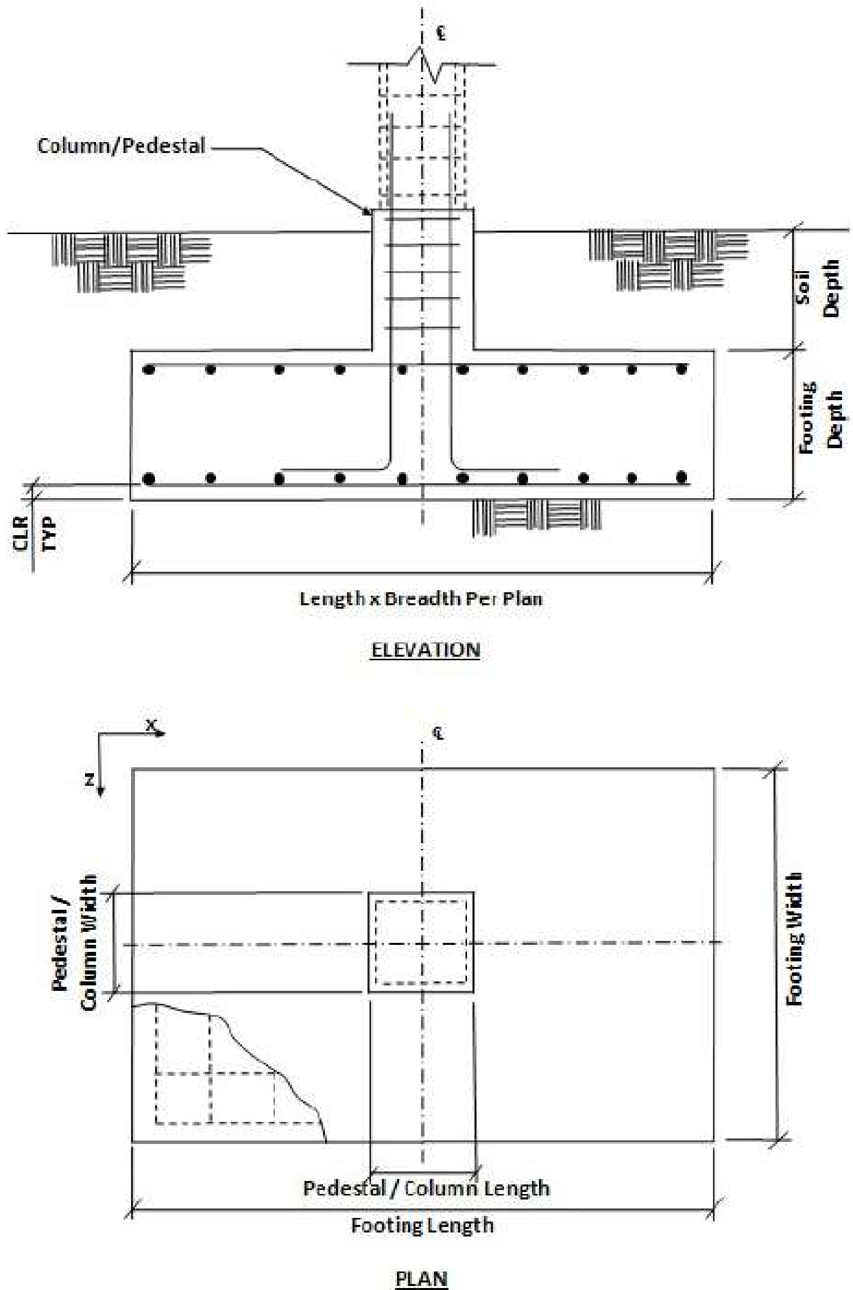


Figure 4.11 Drawing of Foundation

CHAPTER 5: CONCLUSION

We can conclude this project in terms of effective management of architectural and structural work, because both are very important for any public building. Some key points are following:

- Any bus stand need a minimum space for everything (toilet, ticket counter, waiting hall etc.), we carried out a brief survey and made this bus stand according to the requirements.
- Since economy is a big factor in any project, we used both concrete structures and steel structures for more durability and less expenses.
- We have used a hipped roof which is very useful and less prior to wind loads in comparison to other simple roofs.
- Our structure is lightweight since we used steel structure in roof by which our columns and footings do not have to handle very high amount of load.
- Architectural drawings and renderings shows a complete life like experiences of this building so that we can experience and modify the structure of building if need according to the requirements.
- We have used isolated foundation because the area of foundation is less than 60 % of total area which restricts us to make isolated foundation and not to make raft foundation.
- We think this project work is very helpful for a rural area to provide a properly planned and organised bus terminal as well as conducting further research regarding bus terminal facilities.

1.Plan

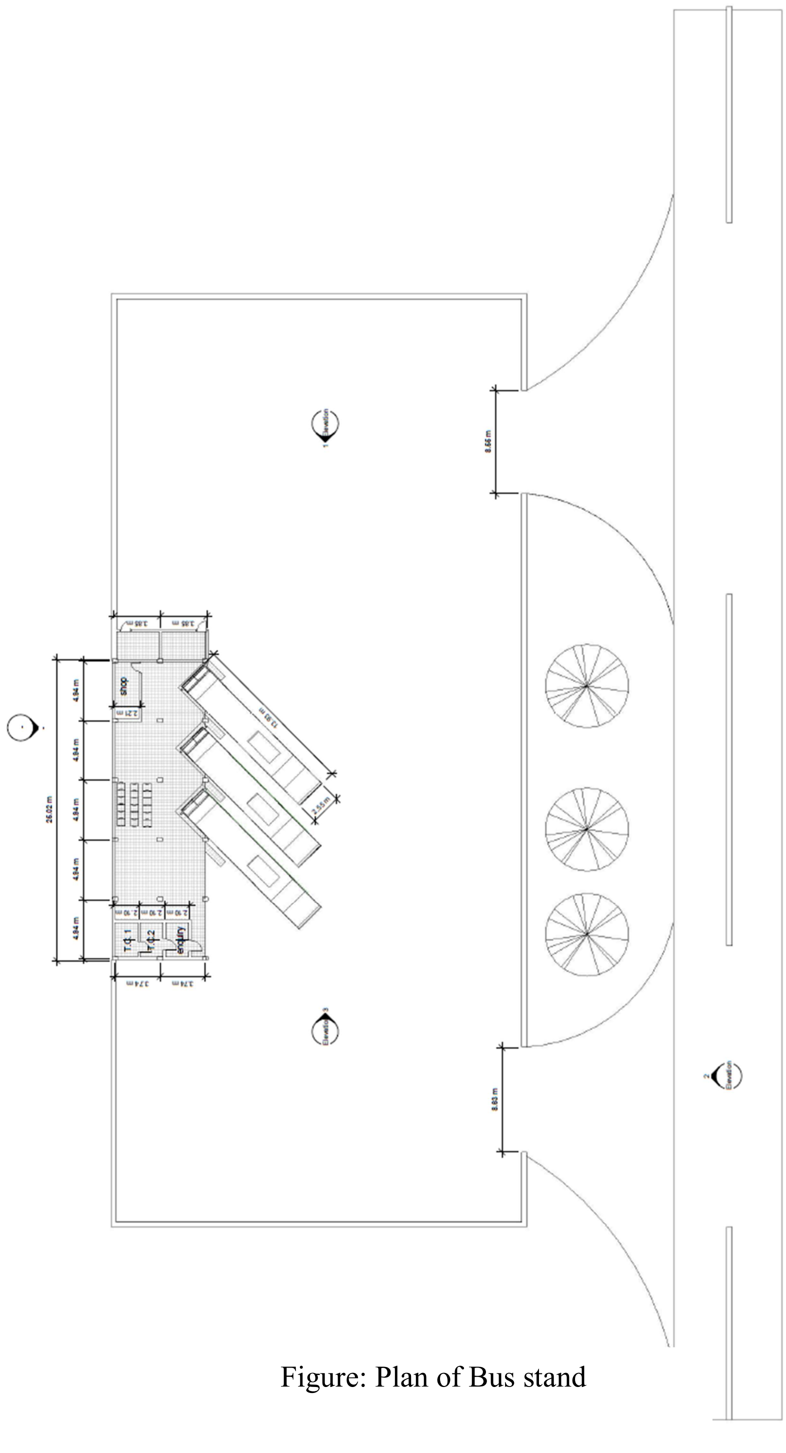


Figure: Plan of Bus stand

2.Elevation 1

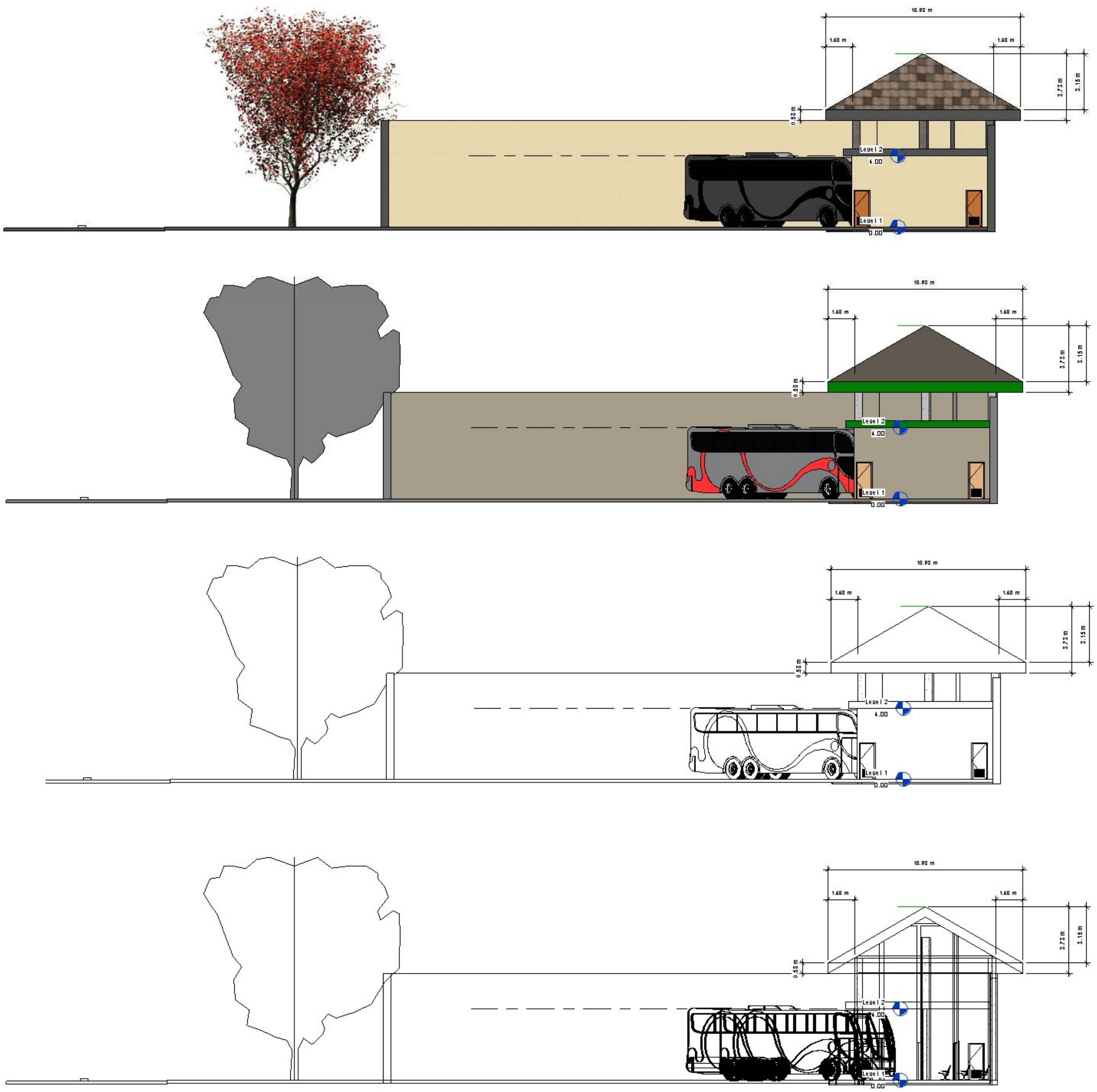


Figure:Elevation 1 of Bus stand

3.Elevation 2

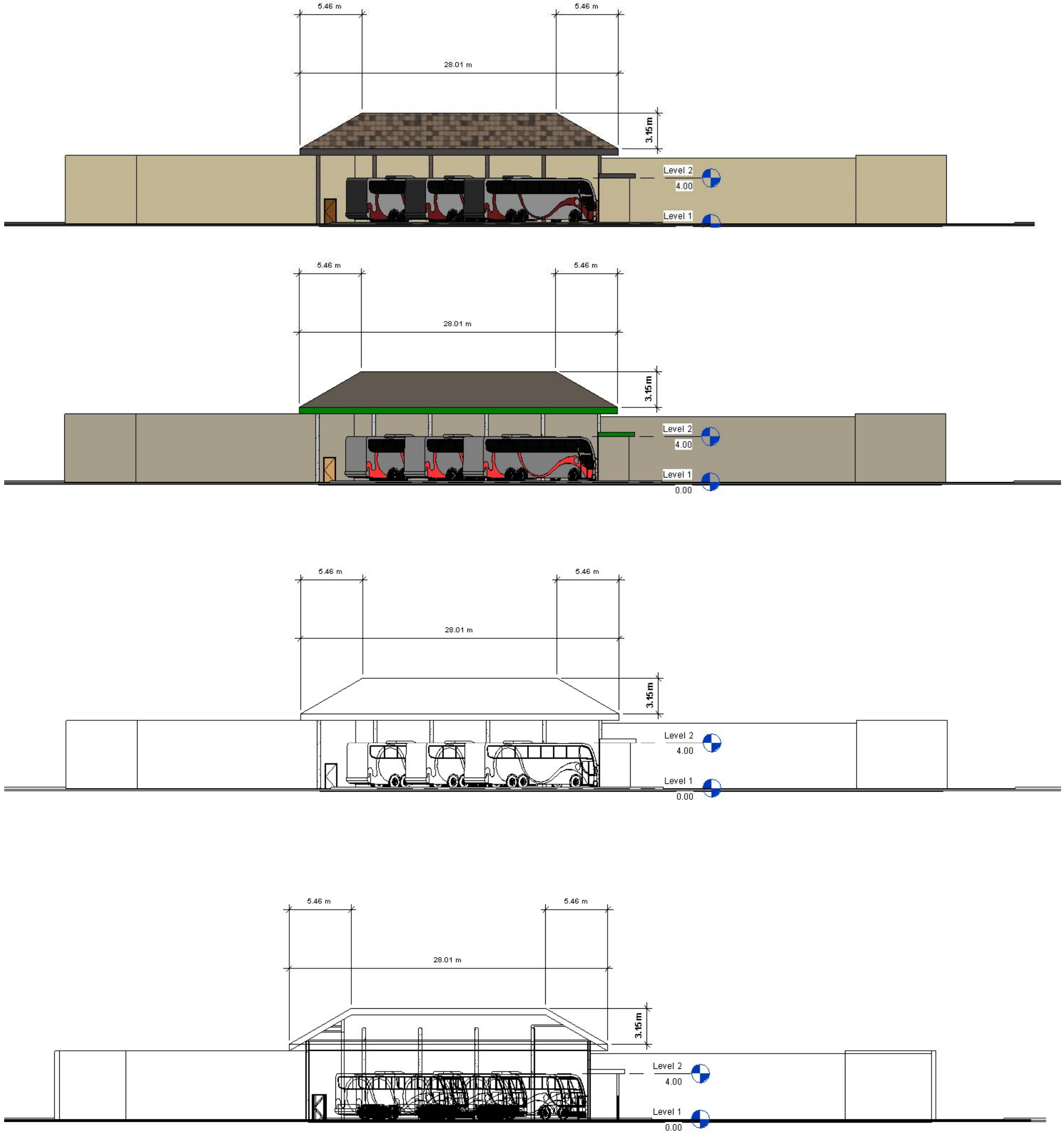


Figure: Elevation 2 of Bus stand

4.Elevation 3

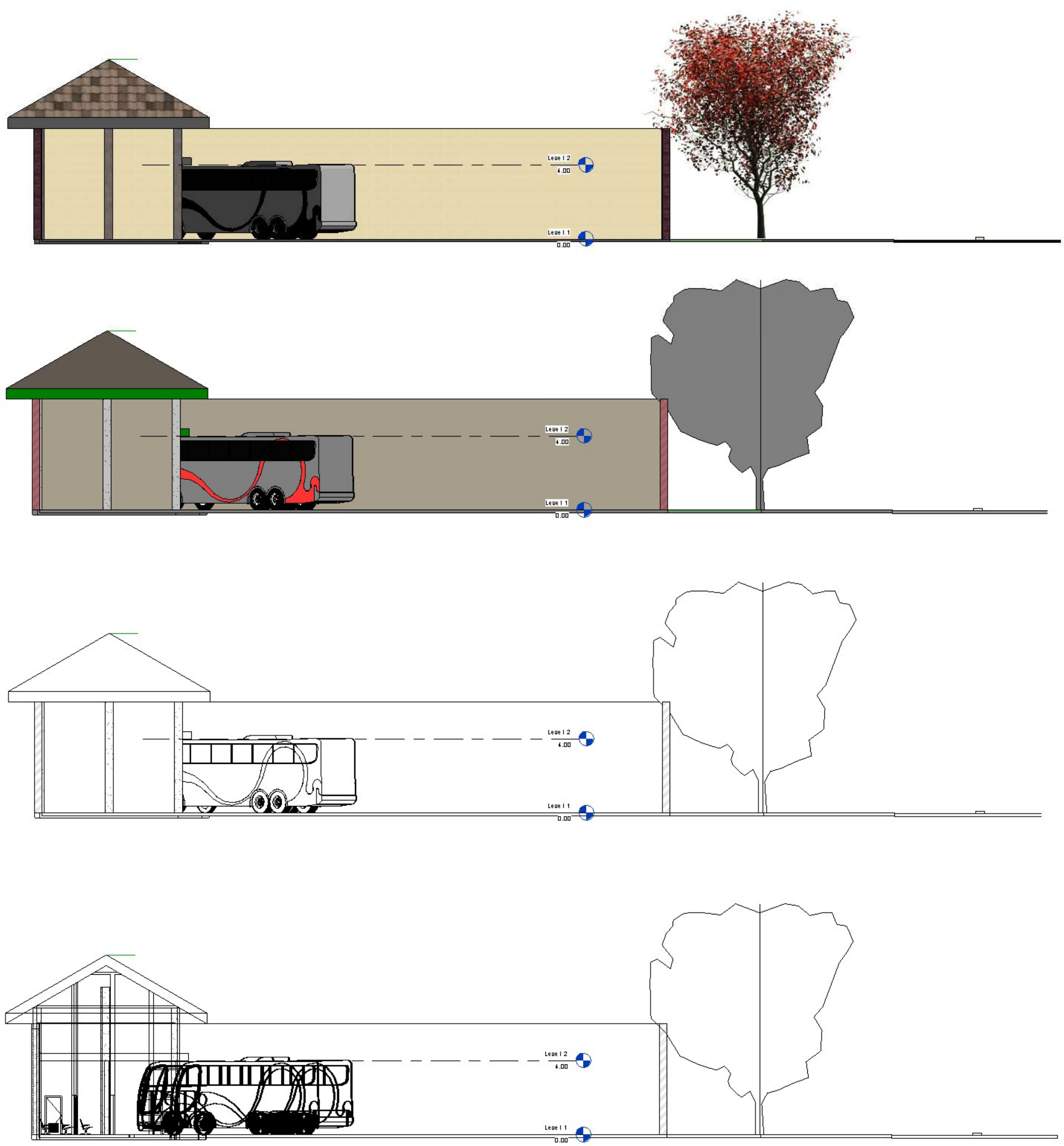
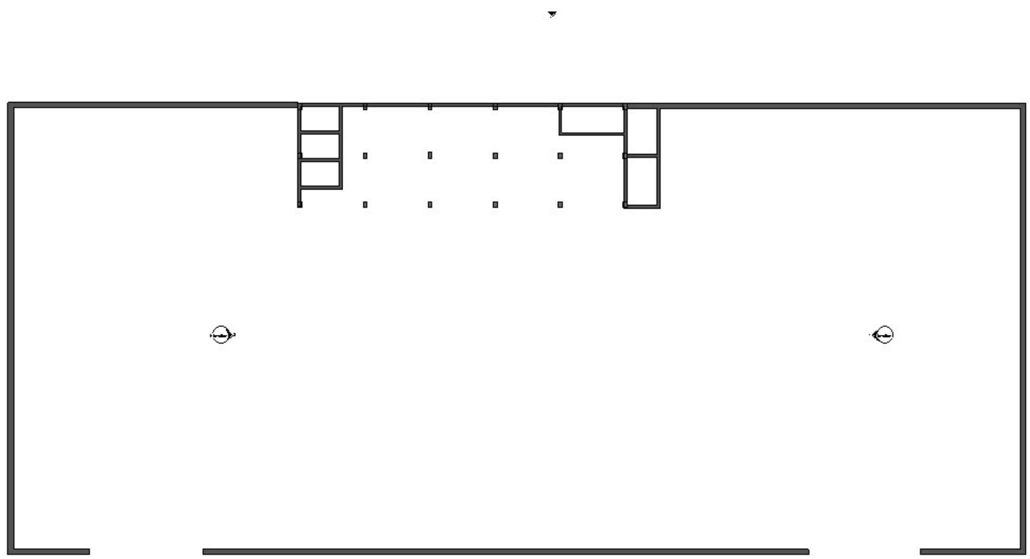
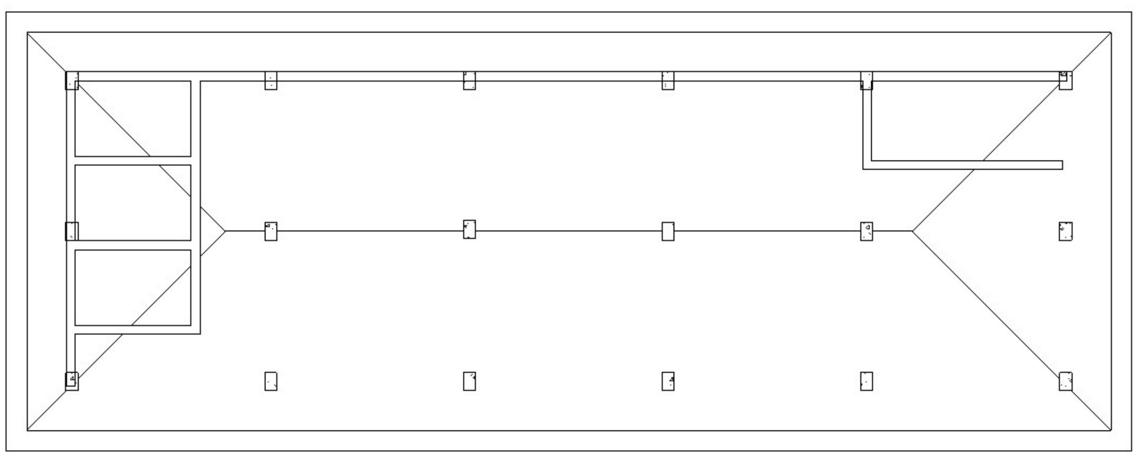


Figure: Elevation 3 of Bus stand

5.Celling plan level 1 and 2





7.Rendered 3d Drawing 1

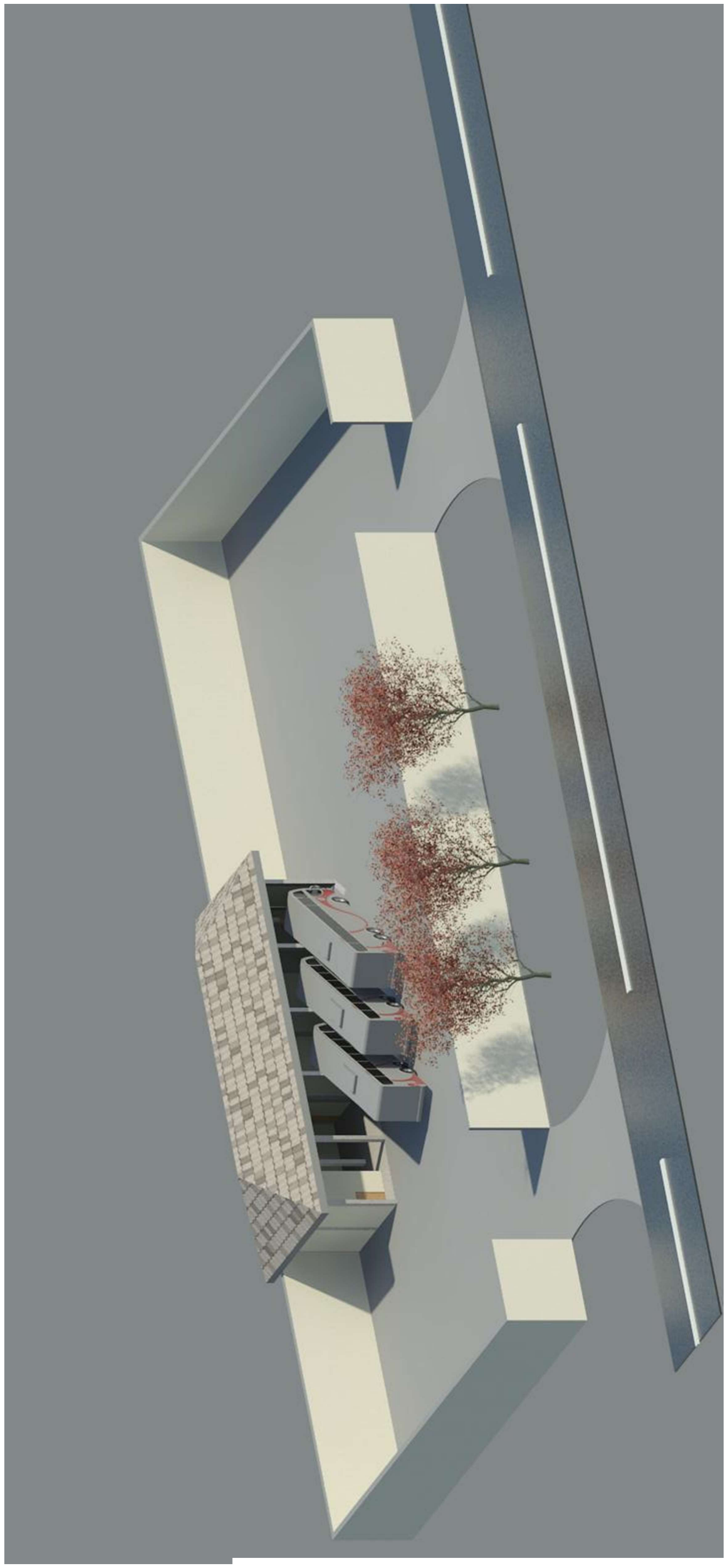


Figure: Rendered 3d Drawing

8. Rendered 3d drawing 2

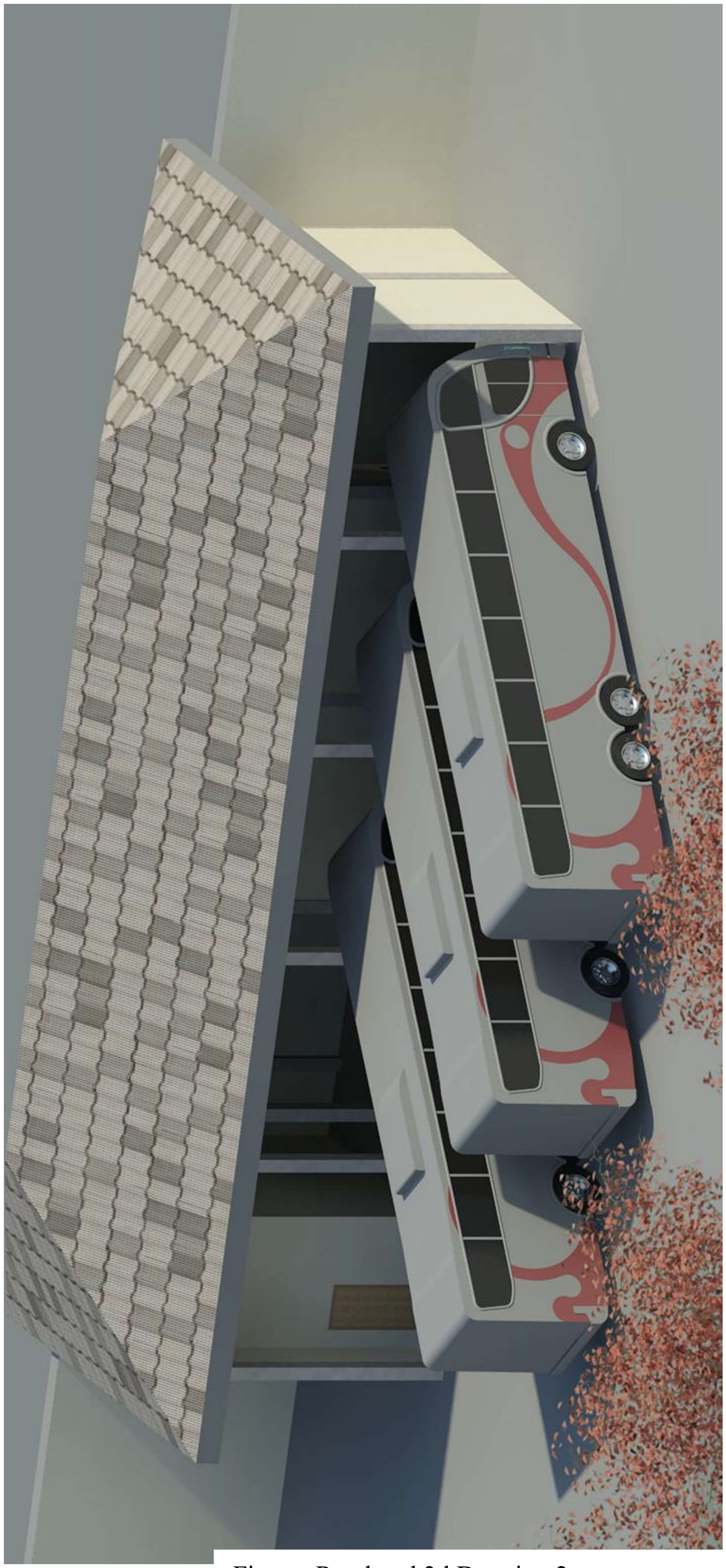
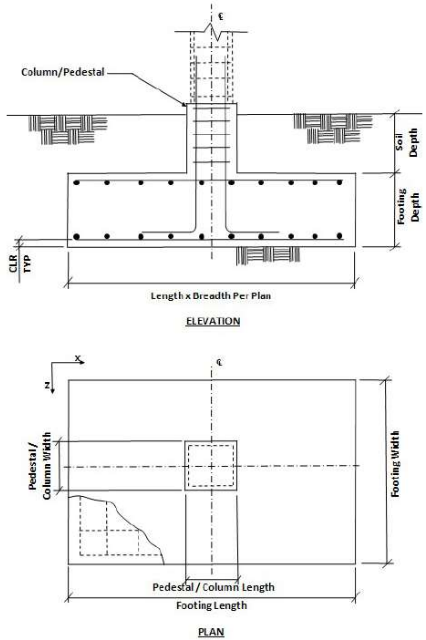


Figure: Rendered 3d Drawing 2

Design example of foundation no.18



Input Values

Footing Geometry

Design Type : Calculate Dimension

Footing Thickness (Ft) : 800.000 mm

Footing Length - X (Fl) : 1800.000 mm

Footing Width - Z (Fw) : 1800.000 mm

Eccentricity along X (Oxd) : 0.000 mm

Eccentricity along Z (Ozd) : 0.000 mm

Column Dimensions

Column Shape : Rectangular

Column Length - X (Pl) : 0.305 m

Column Width - Z (Pw) : 0.305 m

Pedestal

Include Pedestal? No

Pedestal Shape: N/A

Pedestal Height (Ph): N/A

Pedestal Length - X (Pl): N/A

Pedestal Width - Z (Pw): N/A

Design parameters

Concrete and rebar Properties

Unit Weight of Concrete: 25.000 kN/m3

Strength of Concrete: 25.000 N/mm2

Yield Strength of Steel: 415.000 N/mm2

Minimum Bar Size: Ø6

Maximum Bar Size: Ø32

Minimum Bar Spacing: 50.000 mm

Maximum Bar Spacing: 500.000 mm

Pedestal Clear Cover (P, CL): 50.000 mm

Footing Clear Cover (F, CL): 50.000 mm

Soil Properties

Soil Type: Drained

Unit Weight: 20.000 kN/m3

Soil Bearing Capacity: 350.000 kN/m2

Soil Surcharge: 0.000 kN/m2

Depth of Soil above Footing: 500.000 mm

Cohesion: 0.000 kN/m2

Min Percentage of Slab: 0.000

Sliding and overturning

Coefficient of Friction: 0.500

Factor of Safety Against Sliding: 1.500

Factor of Safety Against Overturning: 1.500

Applied Loads - Service Stress Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	12.375	-8.250	0.000	0.000	-0.001
2	73.540	0.000	0.000	0.000	-0.000

Applied Loads - Strength Level

LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	12.375	-8.250	0.000	0.000	-0.001
2	73.540	0.000	0.000	0.000	-0.000

Design Calculations

Initial Length (Lo) = 1.800 m

Initial Width (Wo) = 1.800 m

Uplift force due to buoyancy = 0.000 kN

Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 3.240 m2

Min. area required from bearing pressure, Amin = P / q_{max} = 0.485 m2

Note: A_{min} is an initial estimation.

P = Critical Factored Axial Load (without self-weight/buoyancy/soil).

q_{max} = Respective Factored Bearing Capacity.

Final Footing Size

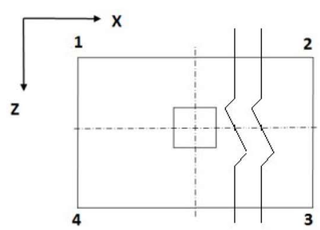
Length (L2) = 1.800 m — Governing Load Case: # 1

Width (W2) = 1.800 m — Governing Load Case: # 1

Depth (D2) = 0.802 m — Governing Load Case: # 1

Area (A2) = 3.240 m2

Pressure at four corner



Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)	Area of footing in uplift (A_u) (m^2)
2	**52.4109**	52.4109	52.4109	52.4109	0.000
2	52.4109	**52.4109**	52.4109	52.4109	0.000
2	52.4109	52.4109	**52.4109**	52.4109	0.000
2	52.4109	52.4109	52.4109	**52.4109**	0.000

If A_u is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressure at Four Corner

Load Case	Pressure at corner 1 (q_1) (kN/m2)	Pressure at corner 2 (q_2) (kN/m2)	Pressure at corner 3 (q_3) (kN/m2)	Pressure at corner 4 (q_4) (kN/m2)
2	**52.4109**	52.4109	52.4109	52.4109
2	52.4109	**52.4109**	52.4109	52.4109
2	52.4109	52.4109	**52.4109**	52.4109
2	52.4109	52.4109	52.4109	**52.4109**

Details of Out-of-Contact Area(If Any)

Governing load case = N/A

Plan area of footing = 3.240 sq.m

Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : 0.000 kN

Governing Restoring Force : 84.906 kN

Minimum Sliding Ratio for the Critical Load Case : 0.000

Critical Load Case for Overturning about X-Direction : 1

Governing Overturning Moment : 0.000 kNm

Governing Resisting Moment : 97.780 kNm

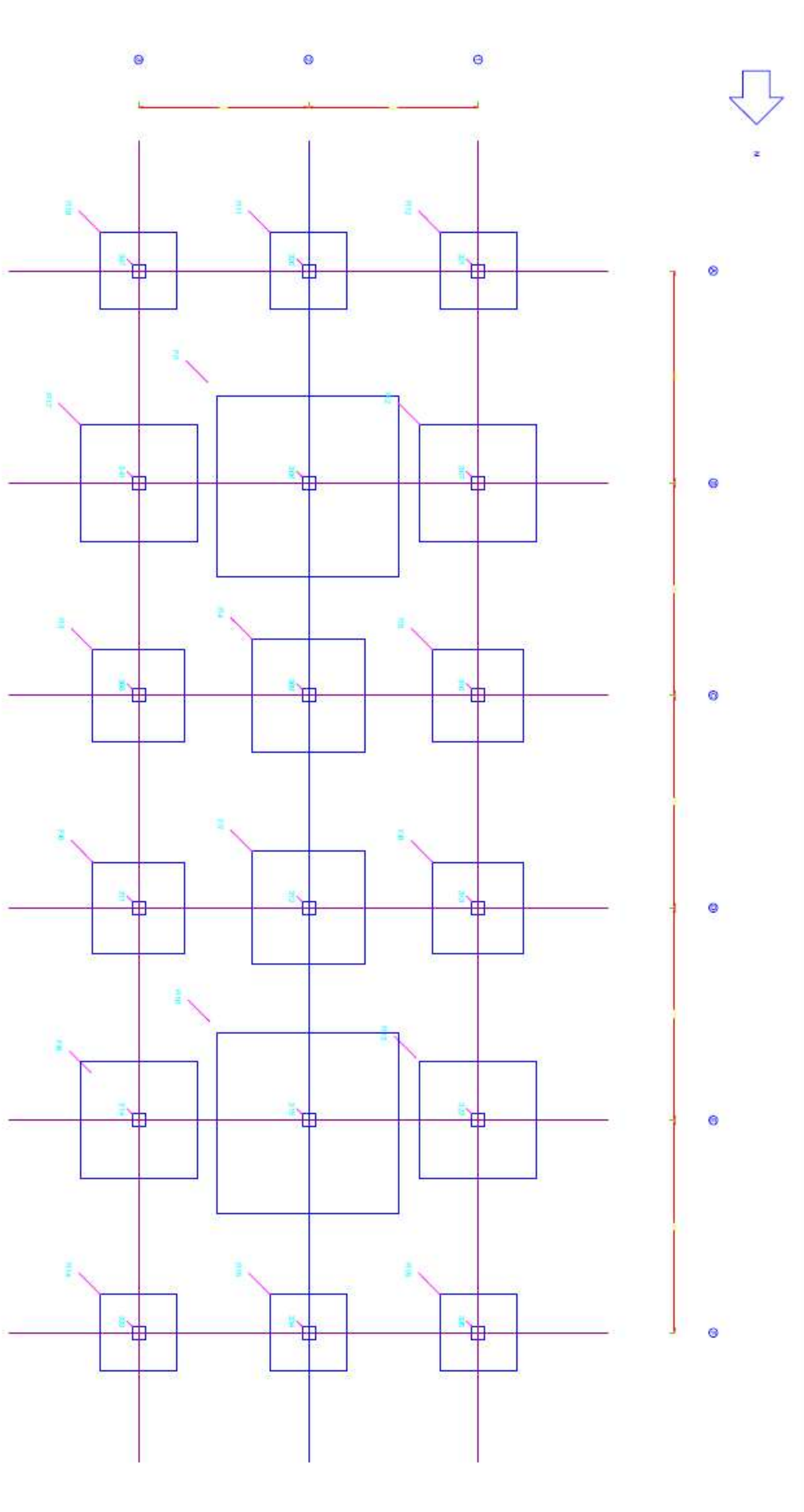
Minimum Overturning Ratio for the Critical Load Case : 0.000

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction

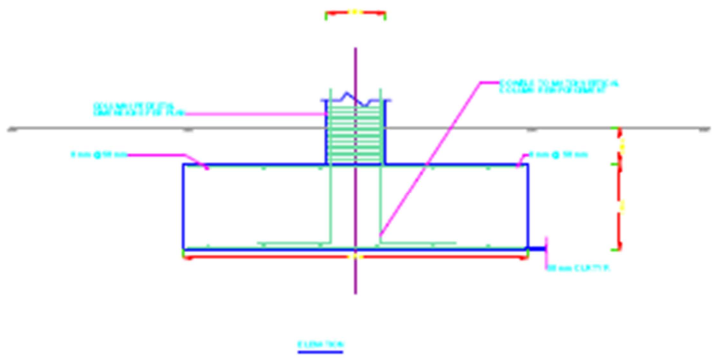
Critical Load Case for Sliding along Z-Direction : 1
Governing Disturbing Force : 0.000 kN
Governing Restoring Force : 54.323 kN
Minimum Sliding Ratio for the Critical Load Case : 0.000
Critical Load Case for Overturning about Z-Direction : 1
Governing Overturning Moment : 6.599 kNm

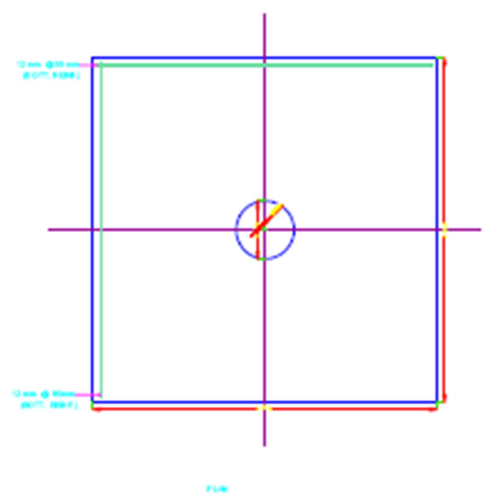
Governing Resisting Moment : 97.780 kNm
Minimum Overturning Ratio for the Critical Load Case : 14.818

Foundation Plan



Foundation Drawing Example





Column Design

COLUMN NO.1 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 307 SHORT COLUMN

REQD. STEEL AREA : 1609.63 Sq.mm.

MAIN REINFORCEMENT : Provide 15 - 12 dia. (0.34%, 1696.46 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 6137.76 M_{uz1} : 557.62 M_{uy1} : 557.62

INTERACTION RATIO: 0.19 (as per Cl. 39.6, IS456:2000)

COLUMN NO.2 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 308 SHORT COLUMN

REQD. STEEL AREA : 1009.30 Sq.mm.

MAIN REINFORCEMENT : Provide 9 - 12 dia. (0.20%, 1017.88 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 5957.66 M_{uz1} : 441.90 M_{uy1} : 441.90

INTERACTION RATIO: 0.22 (as per Cl. 39.6, IS456:2000)

COLUMN NO.3 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 311 SHORT COLUMN

REQD. STEEL AREA : 1009.30 Sq.mm.

MAIN REINFORCEMENT : Provide 9 - 12 dia. (0.20%, 1017.88 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 5957.66 M_{uz1} : 441.90 M_{uy1} : 441.90

INTERACTION RATIO: 0.22 (as per Cl. 39.6, IS456:2000)

COLUMN NO.4 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 287 SHORT COLUMN

REQD. STEEL AREA : 1040.22 Sq.mm.

MAIN REINFORCEMENT : Provide 10 - 12 dia. (0.23%, 1130.97 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

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P_{uz} : 5994.16 M_{uz1} : 0.00 M_{uy1} : 0.00

INTERACTION RATIO: 0.00 (as per Cl. 39.6, IS456:2000)

COLUMN NO.5 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 315 SHORT COLUMN

REQD. STEEL AREA : 9650.97 Sq.mm.

MAIN REINFORCEMENT : Provide 48 - 16 dia. (1.92%, 9650.97 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 255 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 8550.16 M_{uz1} : 706.89 M_{uy1} : 706.89

INTERACTION RATIO: 0.97 (as per Cl. 39.6, IS456:2000)

COLUMN NO.6 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 312 SHORT COLUMN

MAIN REINFORCEMENT : Provide 11 - 12 dia. (0.25%, 1244.07 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 6021.37 M_{uz1} : 493.62 M_{uy1} : 493.62

INTERACTION RATIO: 0.48 (as per Cl. 39.6, IS456:2000)

COLUMN NO.7 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 309 SHORT COLUMN

REQD. STEEL AREA : 1221.69 Sq.mm.

MAIN REINFORCEMENT : Provide 11 - 12 dia. (0.25%, 1244.07 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 6021.37 Muz1 : 493.62 M_{uy1} : 493.62

INTERACTION RATIO: 0.48 (as per Cl. 39.6, IS456:2000)

COLUMN NO.8 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 306 SHORT COLUMN

REQD. STEEL AREA : 10455.22 Sq.mm.

MAIN REINFORCEMENT : Provide 52 - 16 dia. (2.08%, 10455.22 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT: Provide 8 mm dia. circular ties @ 255 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 8791.43 M_{uz1} : 699.79 M_{uy1} : 699.79

INTERACTION RATIO: 0.99 (as per Cl. 39.6, IS456:2000)

COLUMN NO.9 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 2 END JOINT: 321 SHORT COLUMN

REQD. STEEL AREA : 52.69 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.18%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS)

P_{uz} : 5926.30 KNS

COLUMN NO.10 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 2 END JOINT: 320 SHORT COLUMN

REQD. STEEL AREA : 52.23 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.18%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS)

P_{uz} : 5926.30 KNS

COLUMN NO.11 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 310 SHORT COLUMN

REQD. STEEL AREA : 1009.30 Sq.mm.

MAIN REINFORCEMENT : Provide 9 - 12 dia. (0.20%, 1017.88 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 5957.66 M_{uz1} : 441.90 M_{uy1} : 441.90

INTERACTION RATIO: 0.22 (as per Cl. 39.6, IS456:2000)

COLUMN NO.12 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 313 SHORT COLUMN

REQD. STEEL AREA : 1009.30 Sq.mm.

MAIN REINFORCEMENT : Provide 9 - 12 dia. (0.20%, 1017.88 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 5957.66 M_{uz1} : 441.90 M_{uy1} : 441.90

INTERACTION RATIO: 0.22 (as per Cl. 39.6, IS456:2000)

COLUMN NO.13 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 323 SHORT COLUMN

REQD. STEEL AREA : 1829.46 Sq.mm.

MAIN REINFORCEMENT : Provide 17 - 12 dia. (0.38%, 1922.65 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 6203.70 M_{uz1} : 577.41 M_{uy1} : 577.41

INTERACTION RATIO: 0.18 (as per Cl. 39.6, IS456:2000)

COLUMN NO.14 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 2 END JOINT: 333 SHORT COLUMN

REQD. STEEL AREA : 53.78 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.18%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS)

P_{uz} : 5926.30 KNS

COLUMN NO.15 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 2 END JOINT: 334 SHORT COLUMN

REQD. STEEL AREA : 50.98 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.18%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS)

P_{uz} : 5926.30 KNS

COLUMN NO.16 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 2 END JOINT: 335 SHORT COLUMN

REQD. STEEL AREA : 53.62 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.18%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS)

P_{uz} : 5926.30 KNS

COLUMN NO.17 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 1 END JOINT: 341 SHORT COLUMN

REQD. STEEL AREA : 1609.63 Sq.mm.

MAIN REINFORCEMENT : Provide 15 - 12 dia. (0.34%, 1696.46 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

SECTION CAPACITY (KNS-MET)

P_{uz} : 6137.76 M_{uz1} : 557.62 M_{uy1} : 557.62

INTERACTION RATIO: 0.19 (as per Cl. 39.6, IS456:2000)

COLUMN NO.18 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 6000.0 mm CROSS SECTION: 800.0 mm dia. COVER: 40.0 mm

** GUIDING LOAD CASE: 2 END JOINT: 347 SHORT COLUMN

REQD. STEEL AREA : 52.69 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.18%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. circular ties @ 190 mm c/c

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P_{uz}: 5670.67 M_{uz1}: 34.85 M_{uy1} : 34.85

INTERACTION RATIO: 0.16 (as per Cl. 39.6, IS456:2000)

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