DIGITAL ARCHITECTURE-
A Revolutionary Approach

PROPOSED INSTITUTE FOR
RESEARCH AND DEVELOPMENT
IN DIGITAL ARCHITECTURE

By

SIDDHARTH JAIN

A REPORT

Submitted in partial fulfillment of the requirements for the degree of
Bachelor of Architecture.

University of Mumbai

2017

AIKTC SCHOOL OF ARCHITECTURE

CERTIFICATE

This is to certify that the Design Dissertation titled INSTITUE FOR RESEARCH AND DEVELOPMENT IN DIGITAL ARCHITECTURE is the bonafide work of the student SIDDHARTH JAIN from Final Year B. Arch of AIKTC School of Architecture and was car ried out in college under my guidance.

Sign of the guide:

Name of the guide: AR. RAJ MHATRE

Sign of the Dean: _____

Date:

DECLARATION

I hereby declare that this written submission entitled

"INSTITUE FOR RESEARCH AND DEVELOPMENT IN DIGITAL ARCHITECTURE "

represents my ideas in my own words and has not been taken from the work of others (as from books, articles, essays, dissertations, other media and online); and where others' ideas or words have been included, I have adequately cited and referenced the original sources. Direct quotations from books, journal articles, internet sources, other texts, or any other source whatsoever are acknowledged and the source cited are identified in the dissertation references.

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I have read and know the meaning of plagiarism and I understand that plagiarism, collusion, and copying are grave and serious offenses in the university and accept the consequences should I engage in plagiarism, collusion or copying.

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This work, or any part of it, has not been previously submitted by me or any other person for assessment on this or any other course of study.

_____

Signature of the Student:

Name of the Student: SIDDHARTH JAIN

Roll No: 13ARC12

Date: Place:

ACKNOWLEDGEMENTS

As I present this dissertation, I would like to express my gratitude to everyone who helped me with formulation and creation of this project without whom this project would not have been possible.

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I thank the authorities of Makers Asylum, Mumbai, Singhad COA, BNCA and Suzlon One Earth, Pune to for their support and guidance in my project.

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Abstract:

Digital architecture with its significant applications have been a catalyst in changing the way we live and aspire to. The term "Digital Architecture" has been coined by William Gibson in 1984. Many firms all over the world have been practising, experimenting and researching in this field, but all are in silo's.

Based on discussions and talks with experts in the field we might infer that many institutes started experimenting and adding this field as a post graduation program, but very few excelled, but many were shut down because they were not able to produce practical output. The main reason behind shutting the programs were that everyone started a program in the existing college of architecture where most of them had it like an extension to their existing programs.

This experiment which were add-ons; the institutes didn't had enough resources and expertise to execute the innovative ideas in the past.

With the technological advancements, digital architecture covers a wide range of topics under its roof which spreads from product level to urban level projects.

Under digital architecture many topics are covered such as

- Intelligent cities
- Self sufficient buildings
- Intelligent construction
- Computational design
- Self sufficient habitats
- Bionic architecture
- Fractal architecture
- 3-D printed buildings
- Living systems
- Virtual Reality and Augmented Reality
- And Many more.

With this wide range of pallette it has a wide scope of expanding from a course to a full fledged institute which has its prime focus in research and development of existing and future possibilities of this field. It is a creative field where it always looks for something new and innovative, because conscious, premeditated design process has been here for thousands of years, parametric modelling introduces new input to the process, thus has potential of yielding innovation.

Nature has always been giving us inspiration and ideas for the field of innovation. It has always helped us in giving new ways of living and green solutions for the future. It is constantly giving us environmental, economic and health & community benefits. Bionic architecture draws inspiration from nature to create innovative forms which are functional and practical both. Amalgamation of Bionic architecture and Digital architecture can lead to create much efficient and innovative structures.

In Indian context, there are many colleges which teach different aspects of Digital architecture but they all are scattered. Few of the colleges are IIT IDC, CEDAC, Xavier's college and many multimedia institutes. There are two colleges which teach this field in educational programs for M.Arch and none of them have been successful in producing practical outputs (based on the inferences from case studies) which can help students understand the depth and importance of this field in future. Even there are very few firms which have been practising and researching in this field. Resources are very limited in India which leads to Indian students shift to other countries in search of knowledge.

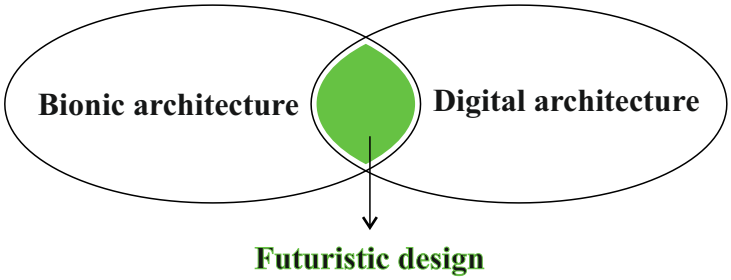
Proposed thesis is more towards on experimental basis for creating an institute for research and development in digital architecture which can provide the lacking resources to the needful and help promoting the field of Digital Architecture in India. The architectural expression of the institute will work towards blending bionic architecture and digital architecture, because when nature and technology goes hand in hand with each other, it can give a better output.

Chapter 2.1
Introduction

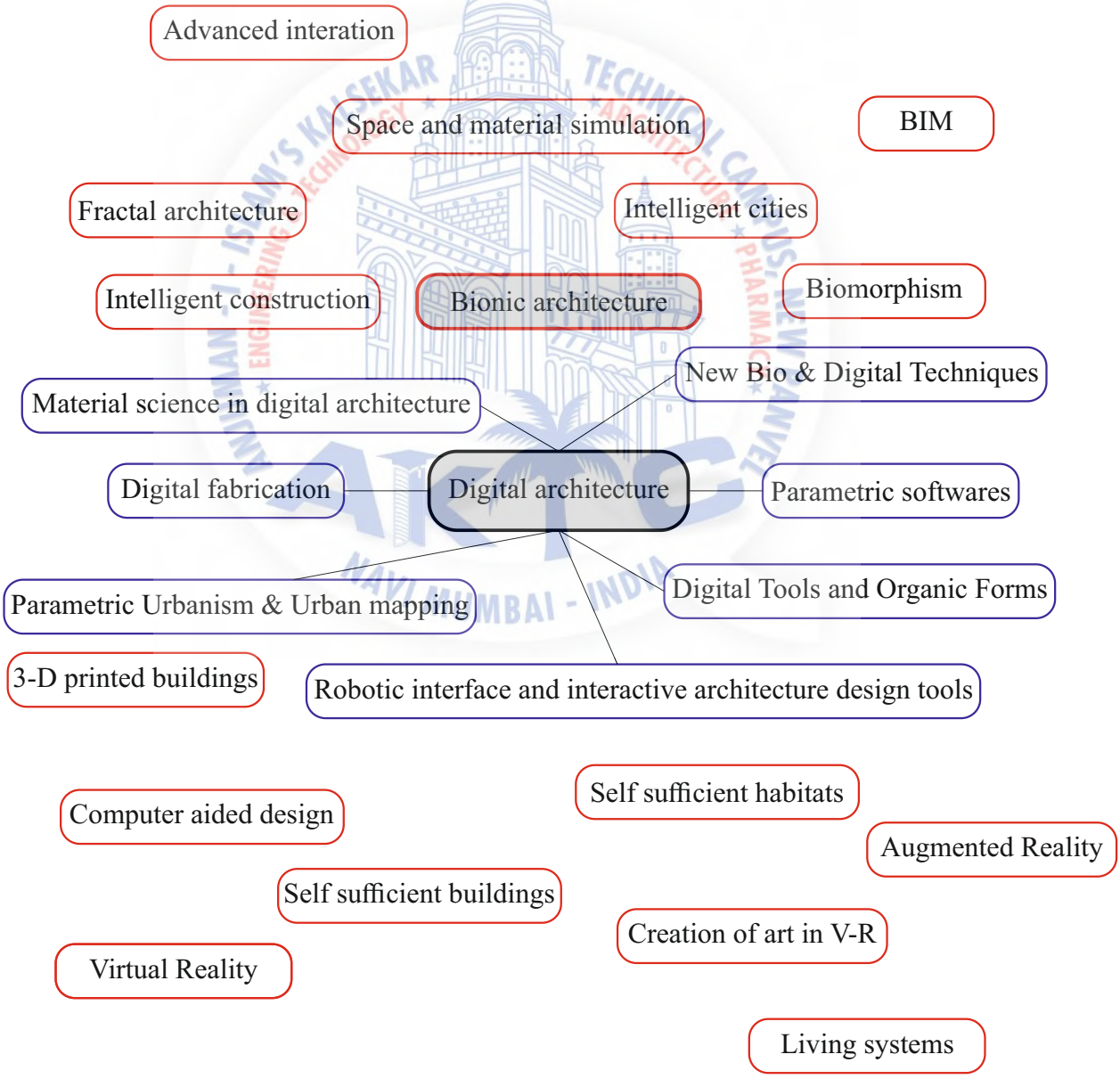
Summarizing the Essence and Scope of Digital Architecture with respect to multiple perspectives of the field.

Introduction

Bionic-architecture and Digital architecture are seen in silo's till now. Each of these fields have reached to enormous levels of innovation. Conventional design processes have been here from years, hence Parametric modelling allows yielding innovation.Parametric design uses Bionic Architecture as an inspiration to develop better forms. Digital architecture helps in yielding faster, efficient and innovative designs.



Digital architecture has various sub headings which it covers, like



In spite of these, Digital tools like Virtual Reality has also advanced where Google tilt Brush, enables anyone to create art in Virtual world, Vivid imaginations which are not bound by time and spaces results in creative creations by people. Virtual reality also enables Architects to simulate and let users experience the 3d virtual model in Time where it can simulate real time effects for better understandings.

3-D printers are now capable of printing our imaginations into real world, so what if we create vivid and innovative ideas in Virtual world and let 3-D printers Bring it to our real world.

The institute will offer an Course and workshops for all these fields which could enable, not only Architects but Engineers and Artists also to learn and simulate these various techniques.

Institute purely looks at how can Sustainabilty and Bio-digital architecture can be clubbed together to create Futuristic Institutes for all. Institute can also contain various programs where local public could also interact and get to know more about Sustainability and other aspects.

The above mentioned nearly covers of what digital architecture covers in academic field and what are its future potential add-ons.

In India, Only 2 colleges teach digital architecture as a master's program which are Sinhagad COA, Pune and BNCA, Pune. Even if this field holds potential and many people wish to learn more about this field, but they don't have enough access to these resources, which is leading to giving less importance to this field.

There are many reasons because of which this field is not booming in India:

1. **Lack of Education sources**: there are very few institutes which teach focus mainly on digital architecture. This is leading to students migrate to different countries in search of knowledge regarding this topic and people are experimenting and executing these type of projects outside India.

2. **Lack of Tools and Machinery**: In entire India there is only one Fablab which is in BNCA, Pune which is used to educate people regarding these future technologies. There are few alternative educations sources like Makers Asylum which gives people access to these machineries to research, innovate, and execute their ideas and turn them into reality.

3. **Lack of Practical execution**: Very few firms in India practice and execute Projects in the field of digital architecture, and they are

A. Nudes, Mumbai.

B. Morphogenesis, New Delhi.

C. Rat[LAB] - Research in Architecture & Technology, New Delhi.

The only reason is that people don't practice this field much is because of its execution cost factor, due to lack of machineries and expertise cost of these projects goes very high.

4.**Cost factor**: If there were many tools and machineries made available to the public, then the cost factor of these projects would have gone down drastically leading to increase in demand for these projects.

Aim : Amalgamation of Bionic and Digital Architecture to create futuristic institute

Objectives :

- To study different aspects of Digital Architecture and its implications
- To study different technologies which can act as plugins to develop Digital Architecture further.
- To study different aspects of Bionics which can help Digital Architecture to perform efficiently.
- To provide lacking resources to create an institute for digital architecture

- **Scope :**
- The institute offers a space for architects, artists and engineers to experiment and innovate in the field of digital architecture.
- It will help the users to transform their vivid imaginations of virtual world into the real world.
- The program can be divided into 40-60 ratio where 40% can consist of institute for learning and 60% can consist of experimental areas and a green park where all the exhibits could be made available to public for awareness in Digital architecture.

Limitations:

- This technology is not available to all and very few architects are aware about it.
- This research is more towards experimental basis.
- So the output would be 100% workable or not is still a question
- Cost of this technology is very high, hence very few use it.

Need for this Institute in Indian context:

By looking at its background, it clearly states that this field of architecture holds a lot of potential to grow and help in innovation of new ideas. It gives a lot of opportunities for research, execution, learning new tools and provide an alternative to conventional architecture. But due to lack of resources masses are not able to understand its importance and hence there is a need for a place where all the aspects of education, execution, tools and machinery are present under one roof.

Hence to promote digital architecture and open new doors for professionals from varied backgrounds, i.e architects, engineers and artists, the thesis proposes a module for an Institute For Research And Development In Digital Architecture and after looking at its post occupancy analysis, where it can be repeated in other parts of India for expanding its reach for the people.

When this institute will open its doors for the masses, it can provide those lacking resources to the people. It will open doors for people to experiment in this field and find cost effective ways to execute any projects related to this field. It can help train professionals not only for its design processes but as well as have knowledge of executing these projects. The institute will provide spaces for the students to work, research, execute and also exhibit their work to the masses.

When more and more people will start knowing about this field then it can showcase how can it be cost effective and help to innovate new ideas.

Research methodology :

- Basic Research: to understand the depth of Digital architecture.
- Why it is important and how can it help in future.
- Historical research: To trace down the history and its roots so that it would help in the development in future.
- Experimental Research: how can it be made user friendly.
- How can it be made cost effective.
- To study its sphere of influence in different fields of architecture

1. Product design.

2. Small scale to Big Architectural projects.

3. Social Projects, etc.

To study its beneficial users and its social benefits.

- Why it is not effectively used in India.
- Exploring interactive learning spaces.
- Collaborating multi-functional spaces. i.e Exhibition and workshop spaces
- How can this institute benefit the community?

Chapter 3.1
Literature Review

In a nutshell, explaining the key words and the jargon of digital architecture.

Literature review

Definations and descriptions

Digital architecture?

Digital Architecture is a field of engineering that utilises digital media in the process of its architectural design. Digital Architecture will help in designing the concept, design development, and detail designing of the architecture's form.

Source:https://www.careerindia.com/courses/unique-courses/what-is-digital-architecture-015089.html

Digital architecture uses computer modeling, programming, simulation and imaging to create both virtual forms and physical structures.

Source:https://en.wikipedia.org/wiki/Digital_architecture

Parametric design?

Parametric design is a process based on algorithmic thinking that enables the expression of parameters and rules that, together, define, encode and clarify the relationship between design intent and design response.

Source:https://en.wikipedia.org/wiki/Parametric_design

Virtual Reality?

The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.

Source: Google Dictionary

Augmented Reality?

A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

Source: Google Dictionary

3-D Printer?

A printer attached to a computer, that can make a solid object from a digital model by printing many separate layers of the object. With this state-of-the-art 3-D printer you can turn your ideas into real objects.

Source: http://dictionary.cambridge.org/dictionary/english/3-d-printer

CNC Machine?

CNC means Computer Numerical Control. This means a computer converts the design produced by Computer Aided Design software (CAD), into numbers. The numbers can be considered to be the coordinates of a graph and they control the movement of the cutter. In this way the computer controls the cutting and shaping of the material.

Source: http://www.technologystudent.com/cam/cnccut1.html

Chapter 3.2
Articles

Expressing digital architecture from the columns of professional experts. This chapter broadly summarizes the potential of Digital architecture.

Articles by Other authors

Exploring The Mind-Blowing Realm Of Digital Architecture

Source:https://www.forbes.com/sites/quora/2016/06/03/exploring-the-mind-blowing-realm-of-digital-architecture/#77902ff170fe

Summary: The articles broadly speaks about the integration of architecture and digital world. It speaks about the benefits of it and how it can benefit many users like architects, client, contractor, the city and realtors.

The integration of architecture and digital realms has endless opportunities, according to Leah Alissa Bayer, architect-in-testing in Silicon Valley. They research in the field of digital architecture and how can it grow more.

It also speaks about how the communication between an architect and the client can be made better, how can it help in design process and a better execution of the project.

It gives some examples of how digital architecture can give produce better results.

1. Realistic renderings and walkthrough, how can it give clients a better understanding of built environment.

2. Intelligent technologies: how does the softwares help us to design more environment friendly designs by doing simulations which tell us more about real life problems which might occur in the post design execution, hence it helps in providing better solutions.

3. Innovation in softwares and tools: Powerful algorithms and computational development created the latest movement, parametric design, allow for innovative structural forms we've never built before. 3D printing, has been a huge player in freeing us from typical construction of prescriptive forms and moving us towards low-waste, on-site robotic manufacturing of extraordinarily advanced, adaptive, and precise structures informed by real-life contextual conditions and user needs.

It overall tells us about the potential digital architecture holds in the future.

The dawn of the virtual reality in architecture | Gunita Kulikovska | TEDxRiga

Source:https://www.youtube.com/watch?v=-KGPf_PM8gQ

Summary: Virtual Reality in Architecture

1. A better ability to think in 3-D

2.it is not just a presentation tool but it can be more educative.

3.it can increase capacity of our brain to understand the drawings and designs in a more better way.

4.it connects humans with architecture in a profound way which we have never seen before.

Advantages of VR check: Less wastage of materials, resources, man-hours on building false expectations

It brings that vivid vision of space into life

Creation of art in Virtual Reality

Digital tools like Virtual Reality has also advanced where Google tilt Brush, enables anyone to create art in Virtual world, Vivid imaginations which are not bound by time and spaces results in creative creations by people. Virtual reality also enables Architects to simulate and let users experience the 3d virtual model in Time where it can simulate real time effects for better understandings.

Fig. 1; *Source: Google images/Google tilt brush*

Chapter 4
Case Studies

A compilation of study and analysis of projects involving the strategies and applications of Digital architecture on different scales. This section sums up the detailed comparative study of design programs across India and overseas.

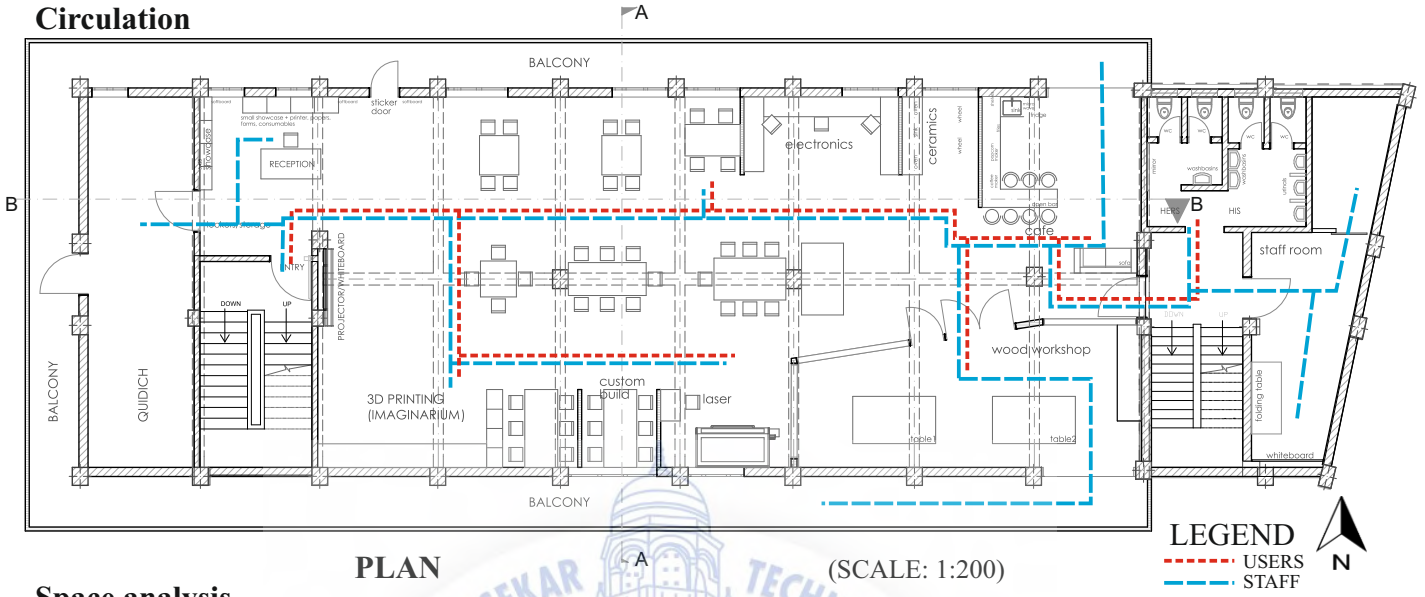
MAKER'S ASYLUM, ANDHERI, MUMBAI

WHY? To study fabrication lab used in public sector

Maker's Asylum is a community makerspace to get your hands dirty and make your ideas happen.

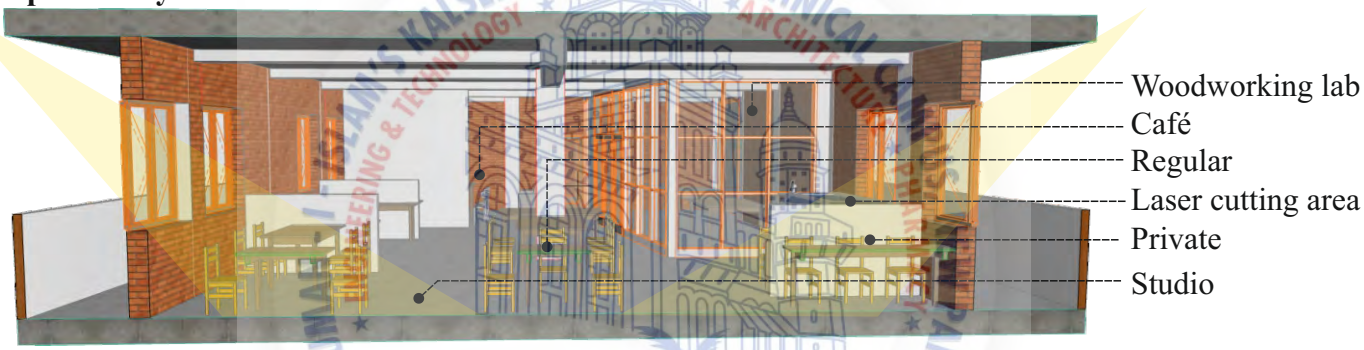
Maker's Asylum Andheri- 6000 sq.ft lab
Maker's Asylum Delhi - 2000 sq.ft lab

Circulation



PLAN (SCALE: 1:200)

Space analysis



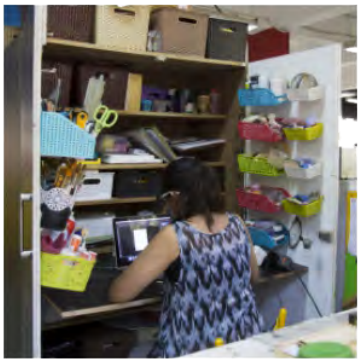
SECTION A-A' (SCALE 1:100)

SECTION B-B' (SCALE 1:200)

TYPES OF WORKSPACES

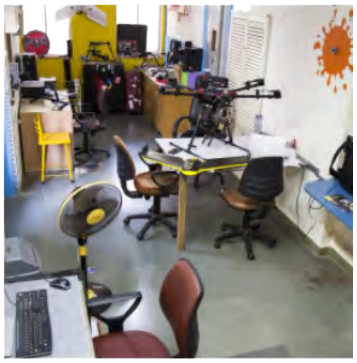
REGULAR

Ideal for individual makers, students, or professionals who need a space to work or make a mess.



STUDIO

Ideal for small teams or even individual designers, artists or anyone else who needs a small, dedicated booth.

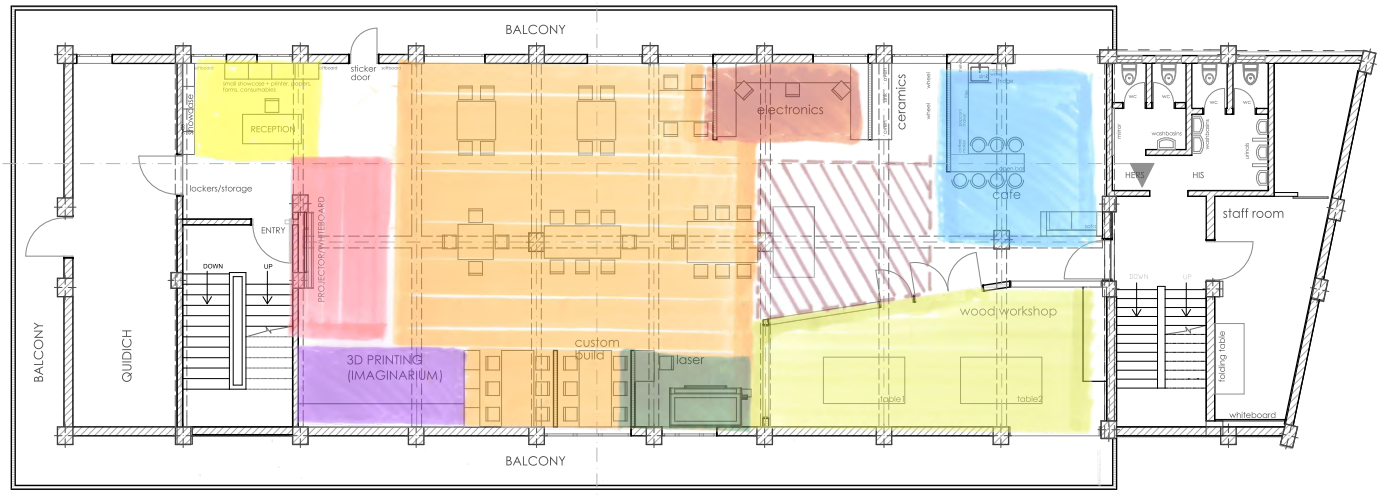


PRIVATE

Ideal for large teams working on hardware, software, social innovation or architecture.

AREA ZONNING

Site area: 560 sq.m



SPACE PROGRAM

RECEPTION: 8.6 m^2
LECTURE AREA: 8 m^2
3-D PRINTING ZONE- 10 m^2
RESEARCH ZONE- 66 m^2
LASER CUTTING ZONE - 9 m^2
WOOD-WORKING LAB- 28 m^2
CAFÉ ZONE- 18 m^2
RECEPTION AREA- 8.6 m^2

Axillary spaces required:

- Quiet space for Reading and Working
- Separate Fabrication lab
- Exhaust for laser cutting and CNC

Types of users

- Owner
- Space manager
- Students
- Professionals
- Kids
- Anyone who loves to build

LEGEND
Reception
Research Zone
Lecture Area
3D-Printing
Electronics Lab
Wood working lab
Laser Cutting
Cafe
Breakout Space.

- 3D printers help only in Prototyping. Not for Large scale projects
- No Space for large Printers for Large scale projects.
- Optimum use of space

- Capacity:-
- 30 people (work)
- 50 people (lecture)
- Flexible space planning
- Research + Fabrication Lab = Output ↑

- Aspirations of Users (Add on)
- textile lab - Ceramic lab - Robotic Arm

- Inter-disciplinary collaoration
- Fun
- Learn
- Experiment

- A place where ideas are converted into reality

LABS

OVERVIEW WORKSPACE

6,000 sq.ft. of space, wifi, work tables, rooftop, a pantry with a fridge full of drinks and some kickass labs for work and fun.

Woodworking
Powered By
Bosch & Dremel

Electronics

3D Printing
Powered By
Imaginarium

Laser Cutting

LASER CUTTING MACHINE

3-D PRINTING MACHINE

WOOD-WORKING LAB- OUTSIDE

WOOD-WORKING LAB-INSIDE

LECTURE SPACE

Fig.2; *Source for images: ©Maker's Asylum official facebook page*

BNCA, PUNE

WHY? To study course module taught in india

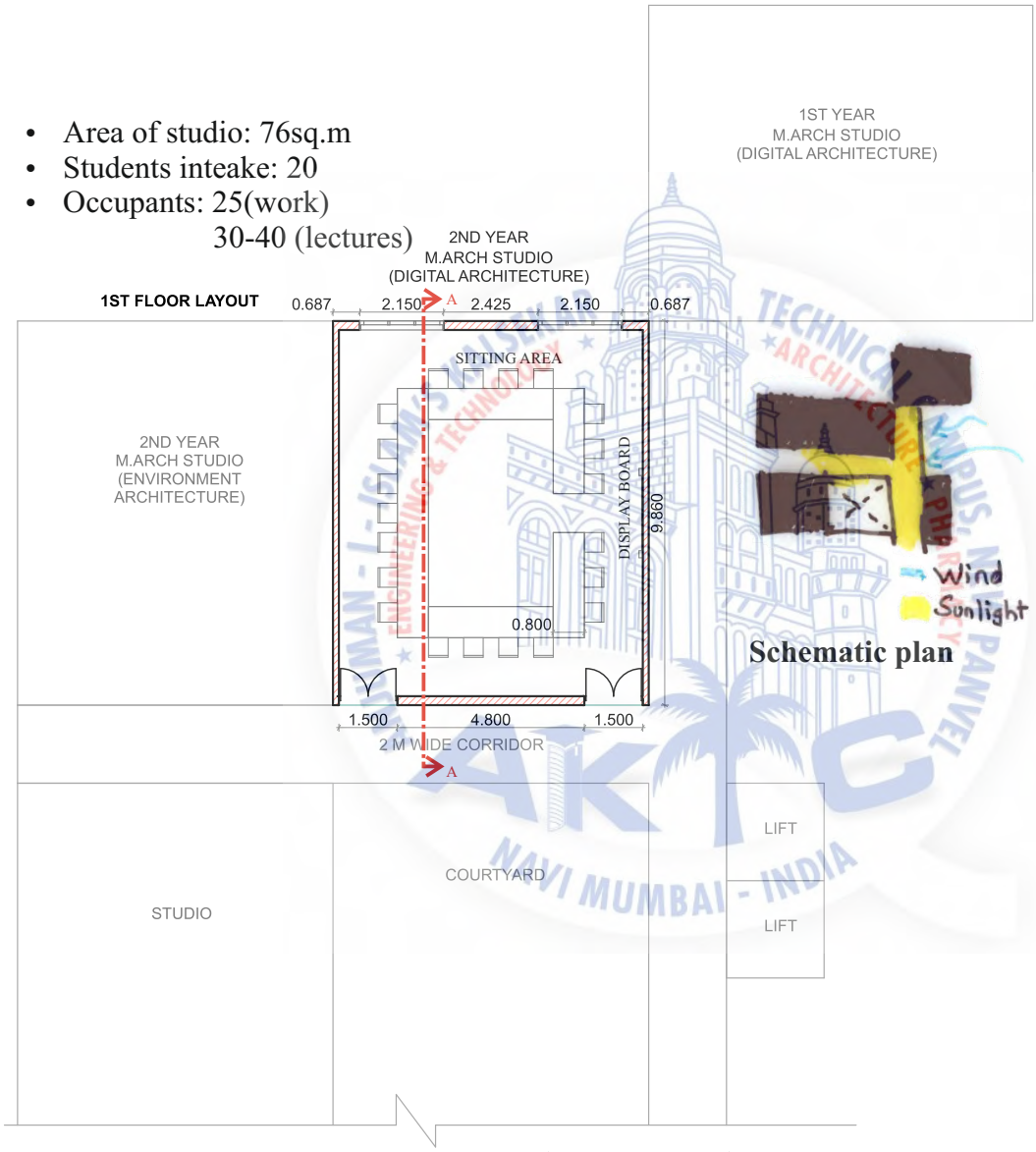
MASTERS IN DIGITAL ARCHITECTURE

- It started in 2013
- The major focus is on-

– Process theories in Digital Architecture
– Parametric Software skill sets
– Digital fabrication and material research
– Digital Design
– Robotic interface and interactive architecture Design Tools

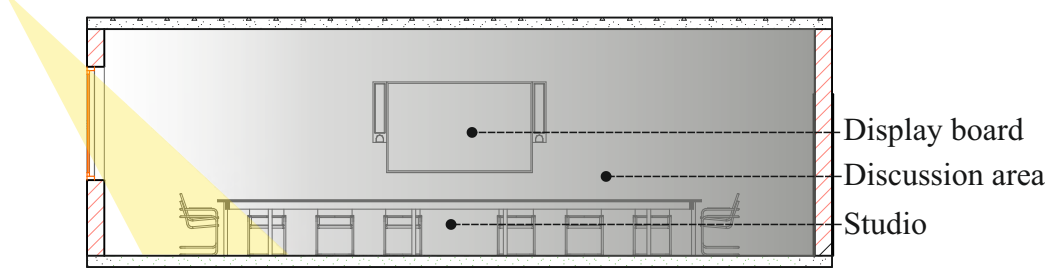
- It is a visiting school for AA school, London

- Area of studio: 76sq.m
- Students inteake: 20
- Occupants: 25(work)
  30-40 (lectures)



Schematic plan

LEARNING STUDIO (SCALE 1:150)



SECTION A-A' (SCALE 1:100)

COURSE MODULE

SEM I

DA - T1	Digital Architecture Process Theories and History 2
DA - T2	Digital Architecture & Psychology
DA - F1	Digital Fabrication 1
DA – S1	Paramteric Software's
DA – DS1 /DS2	Digital Design Studio I
DA- DT1/DT2	Digital Theory Studio I

SEM II

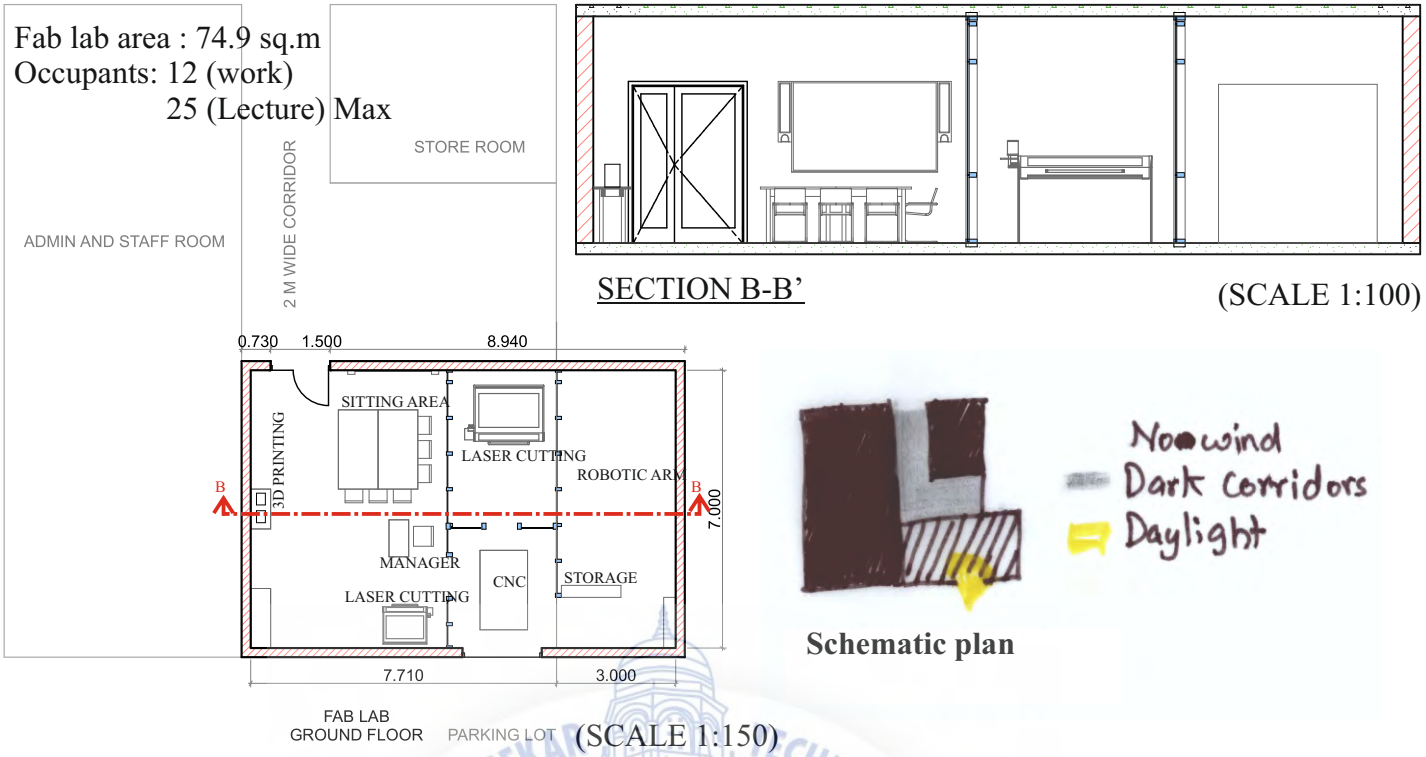
DA – T3	Digital Architecture Process Theories and History 2
DA – T4	Material science and Digital Architecture
DA – F2	Digital Fabrication 2
DA – S2	Analysis Software's
DA- DS3/DS4	Digital Design Studio II
DA- DT3/DT4	Digital Theory Studio II

SEM III

DA – T5	Research in DA
DA – T6	Parametric Urbanism and Urban Mapping
DA – F3	Digital Fabrication 3 (Installation)
DA – T7	Workshops And Seminars
DA- DS5/DS6	Digital Design Studio III
DA- DT5/DT6	Digital theory Studio III

SEM IV

DA - S7	Thesis Design Studio
DA - T8	Culmination of Old and New Theories in Architecture



DIGITAL FABRICATION LAB PLAN

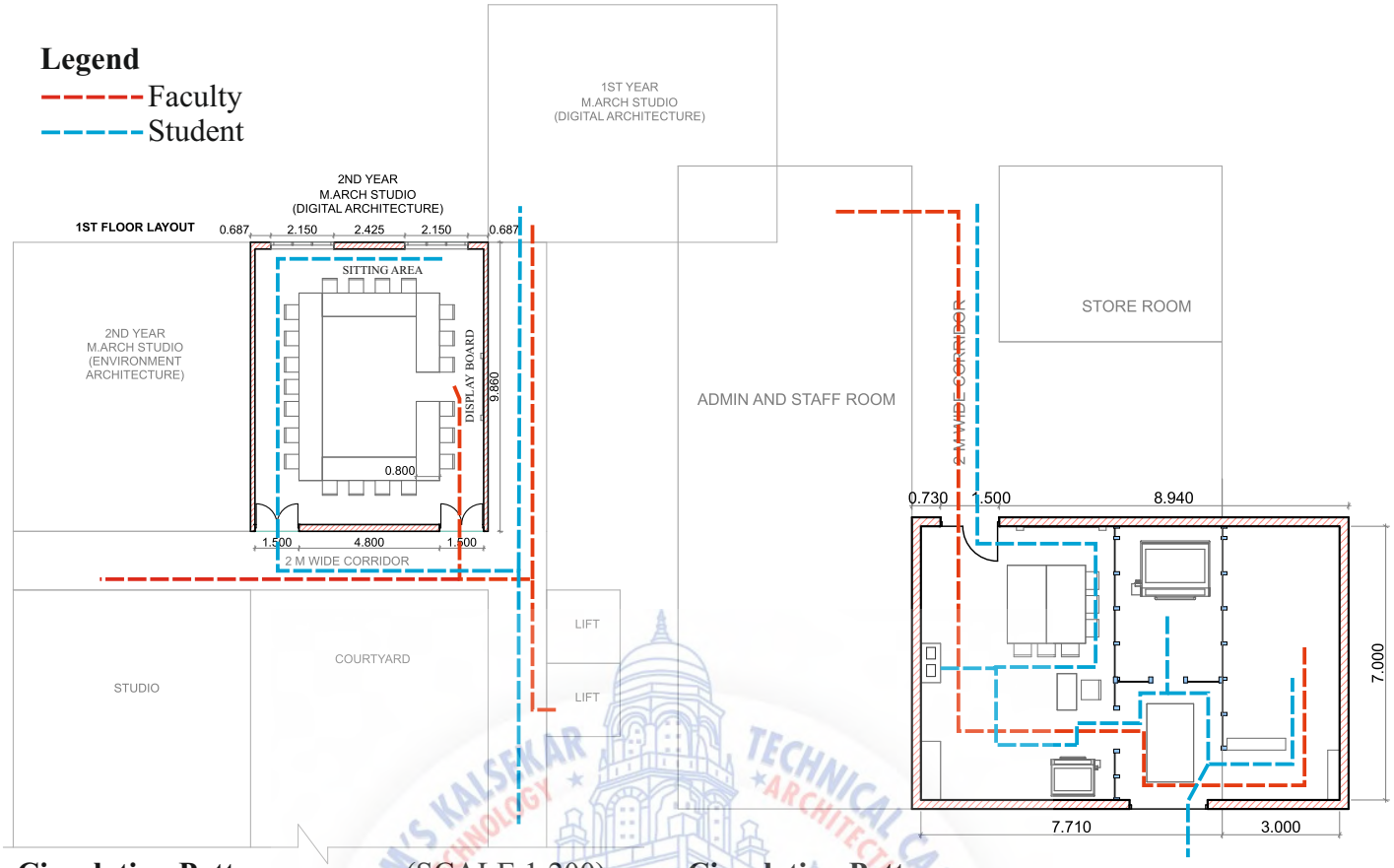
Aspirations of users
- Bigger Fab lab
- VR lab
- Simulation room
- Holographic Projection

Topics Covered in teaching
- Canopies
- Furniture
- Protoyping

Learning stages
Architectural level
↓
Urban level
↓
Thesis

EQUIPMENTS AVAILABLE IN FABRICATION LAB

SR NO	NAME OF THE MACHINE	SIZE OF THE MACHINE	USAGE OF THE MACHINE
1.	Large scale laser cutter TIL - 1360	900mm x 1200mm	real scale project development such as furniture, structures etc.
2.	Large Scale CNC Cutting and Miling Machine	1200mm x 1200mm	real scale project development such as furniture, architectural prototyping etc.
3.	3D printer – PRINTDEL 3D MAX	300mm x 225mm x 200mm	real scale project development such as furniture, architectural prototyping etc
4.	GCC Spirit Laser Cutting Machine	460mm x 740mm	real scale project development such as furniture, architectural prototyping etc
5.	KUKA Robotic arm	2100mm x 2100mm x 2100 mm	Industrial jobs like cutting, miling,range of pick and place operations.



Circulation Pattern of Learning Studio (SCALE 1:200)

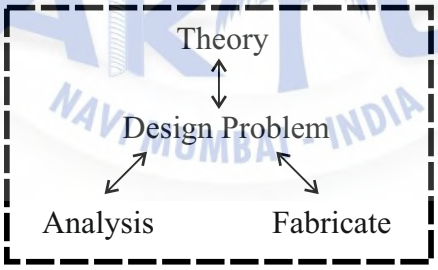
Circulation Pattern of Fab Lab (SCALE 1:150)

Merits:

- Only institute to have an robotic arm to make large scale project.
- Leading institute in India for Digital Architecture

Space v/s functionality:

- Studio not designed for Digital architecture course.
- Non-contextual design
- No exhuast in Fab lab
- Only Fab Lab in India used for education purpose



Types of 3-D Printers:

1.FDM (Fused depositing modelling)

-More wastage -More Material needed

-Cannot Reuse residue -Slow Speed

2.SLS (Selective Laser Sintering)

-Zero wastage -Uses Powder for printing

-Reuse of residue -More Precision

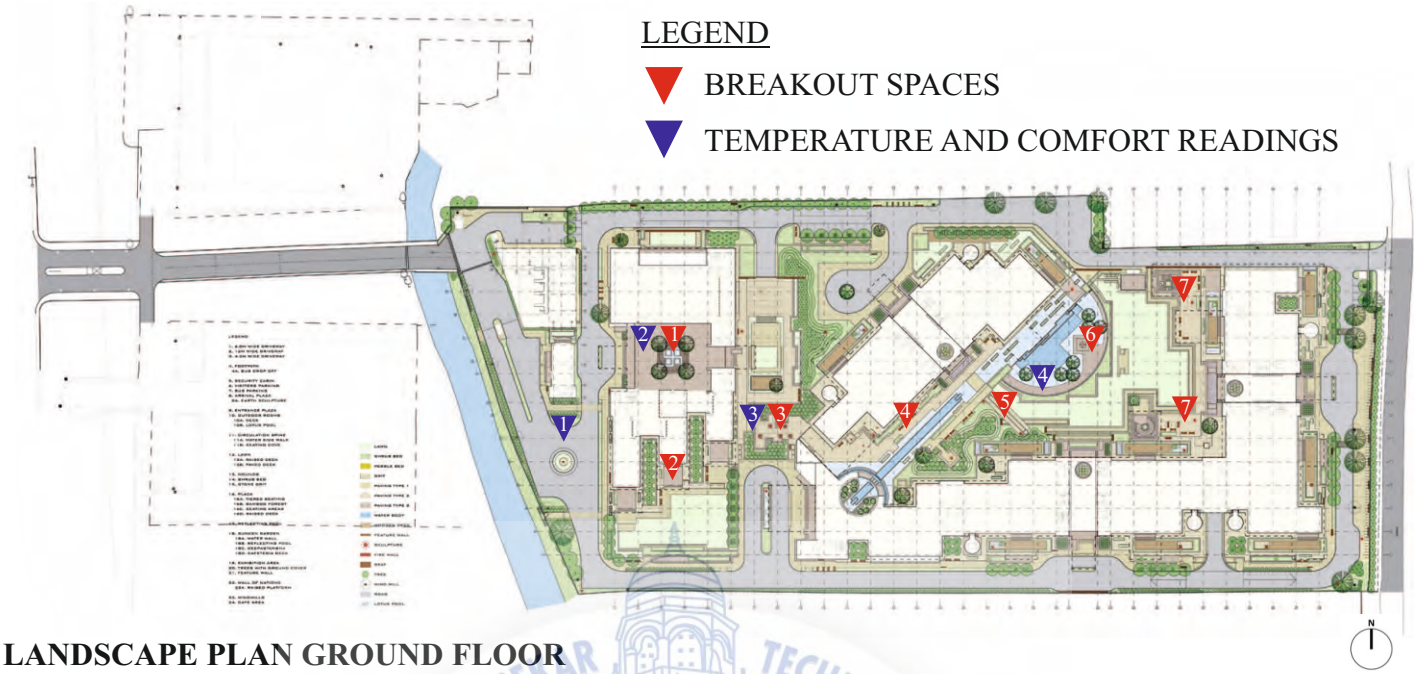
-Medium Speed

3.Resin Printing

-Uses Liquid for Printing -Faster Process

-Fast Printing -Less wastage

SUZLON ONE EARTH, PUNE, INDIA **WHY?** To study sustainable strategies for designing in pune



LANDSCAPE PLAN GROUND FLOOR

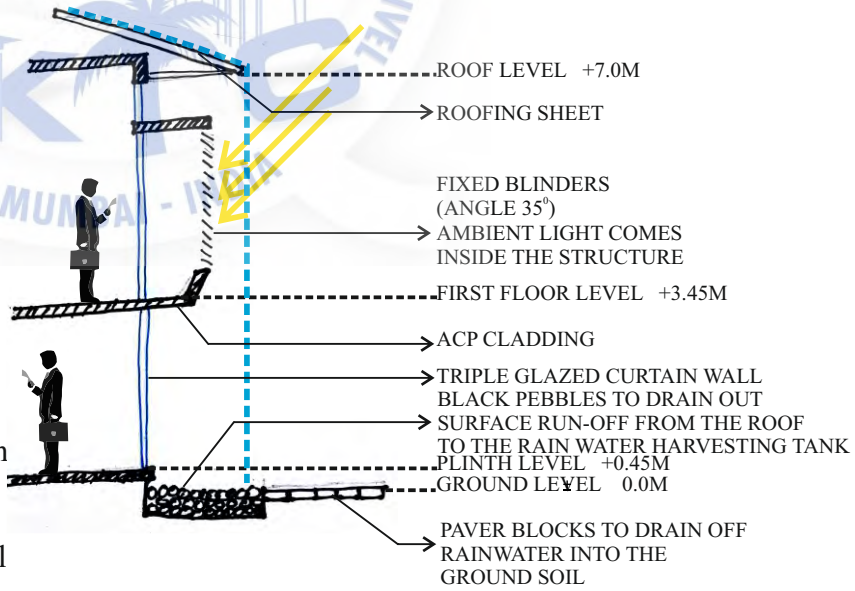
1. 26.0 MIN 73% HUMIDITY 9.52AM
   27.1 MAX 75% HUMIDITY
2. 23.0 MIN 65% HUMIDITY 10.41 AM
   24.0 MAX 68% HUMIDITY
3. 28.0 MIN 65% HUMIDITY 11.00AM
   30.2 MAX 68% HUMIDITY
4. 29.0 MIN 65% HUMIDITY 12.20 AM
   31.0 MAX 68% HUMIDITY

Project information

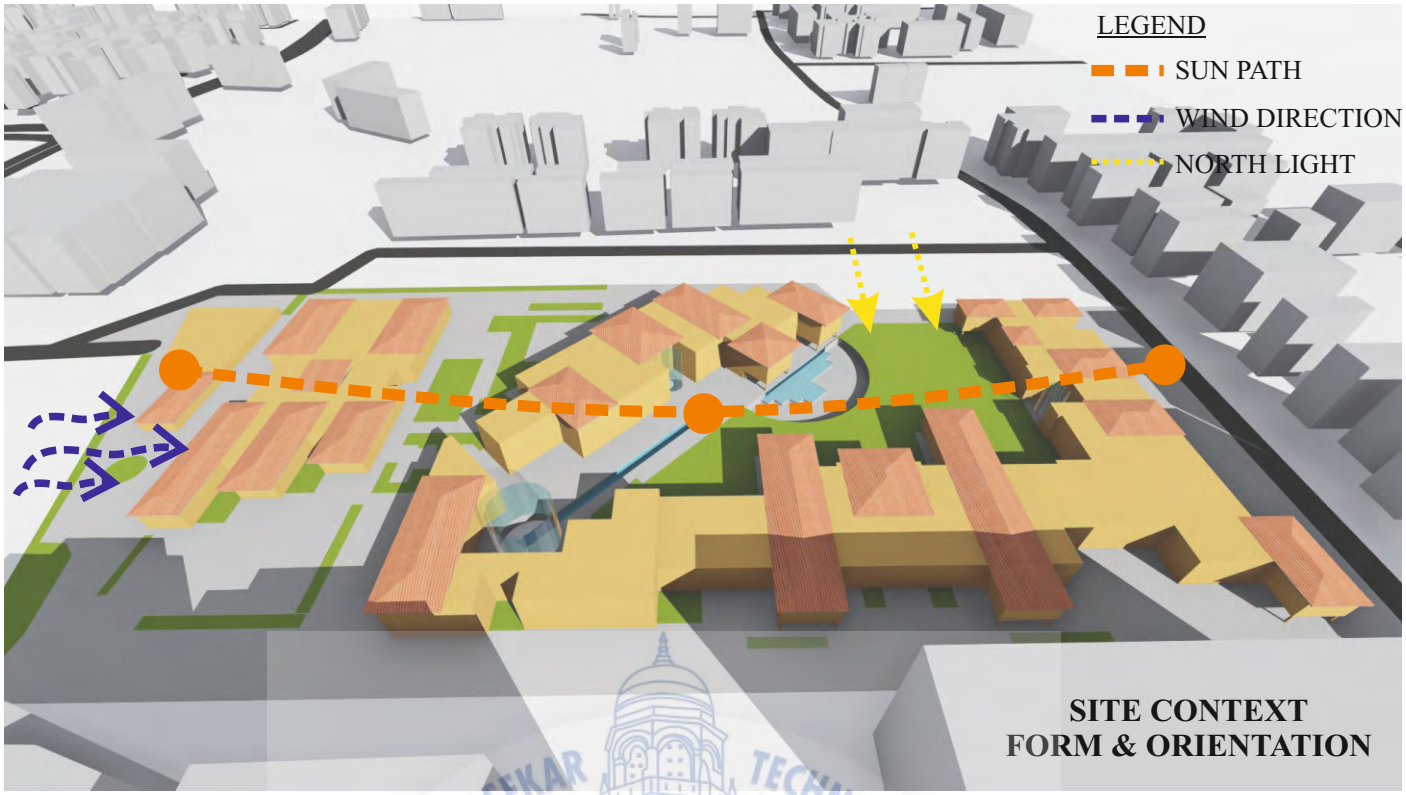
Location: Pune, Maharashtra, India

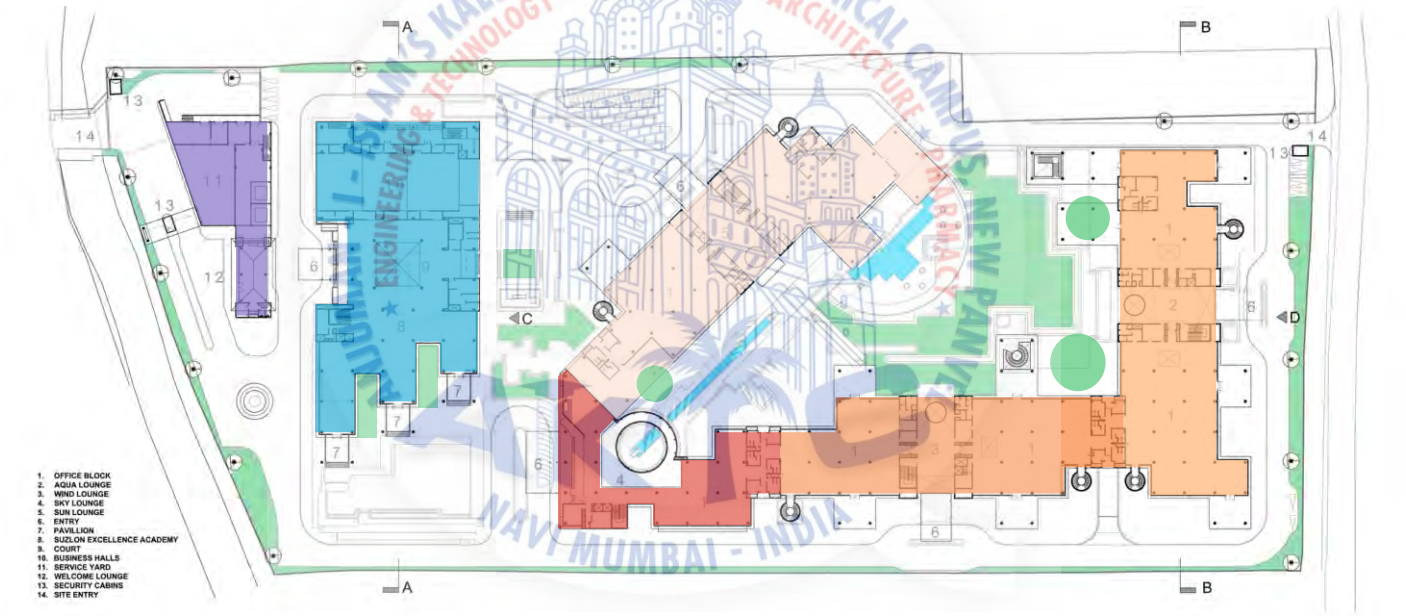
Built Up Area: 75,825 SQ.M
Site Area: 42087.31 SQ.M
Completion: 2009
Cost : Rs.280 crores US$ 63 million (2009)
Occupant capacity: 2300 people
No. of Floors: 3

Services:
Principle Architect : Christopher Charles benninger
Structural Design : Dr. Santhosh ,Vastech
Landscape Design : Ravi & Varsha Gavandi Landscape Architects, Pune
Interior Design : Space Matrix in association with Manish Banker, Tao Architects, Pune, India
Green Building Consultants : Environmental Design Solution, New Delhi
GRIHA: 5 STAR RATING
LEED: PLATINUM RATING



TYPICAL BUILDING SECTION





SITE ZONNING

Suzlon One Earth Global Corporate Headquarters, Pune.

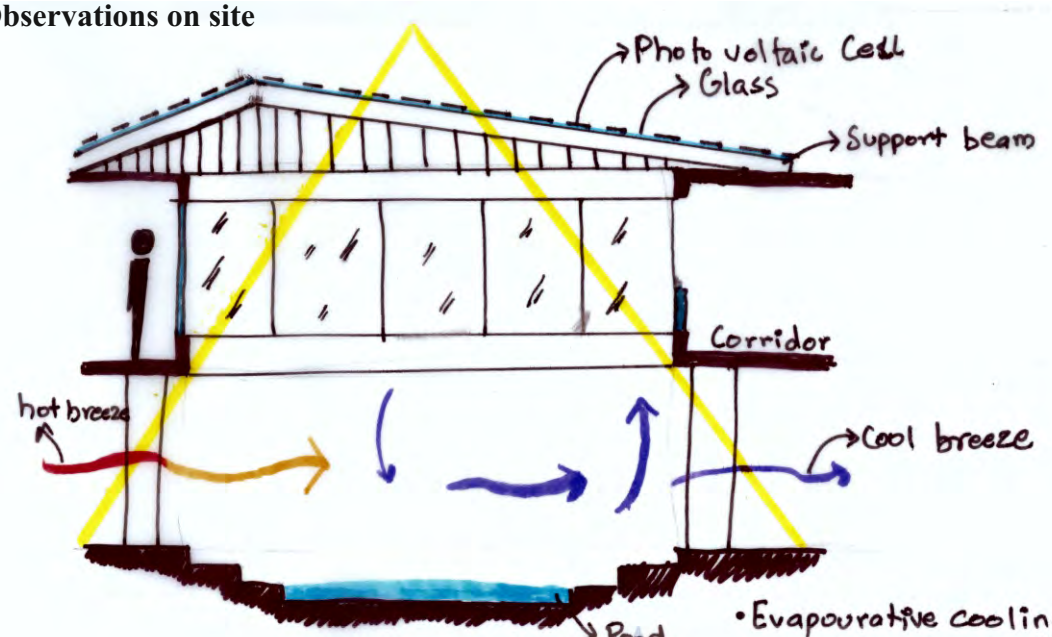
Ground Floor Plan

SR NO.	**TYPES OF STORAGE TANKS**	STORAGE CAPACITY
1.	FIRE FIGHTING	2.75 LAKH LTS
2.	RAINWATER HARVESTING	10 LAKH LTS
3.	HVAC & GARDENING	4.4 LAKH LTS
4.	DOMESTIC USE	1.5 LAKH LTS
5.	RAW WATER	0.5 LAKH LTS

LEGEND

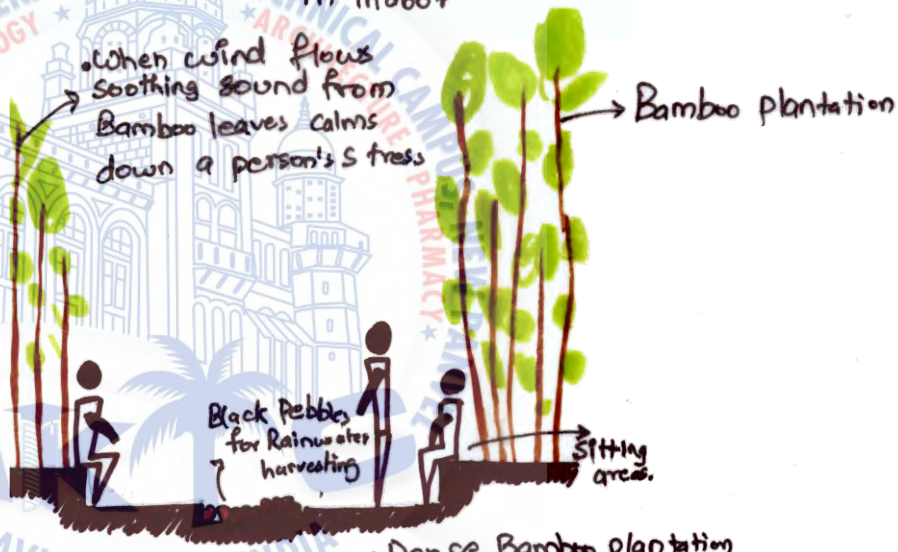
- SERVICE BUILDING
- SEA- LEARNING ACADEMY
- WORK SPACE
- HEAD STAFF AND OWNERS
- IT ZONE
- RESEARCH ZONE
- BREAKOUT AND GREEN SPACES
- WATER BODY
- WINDMILL

Observations on site



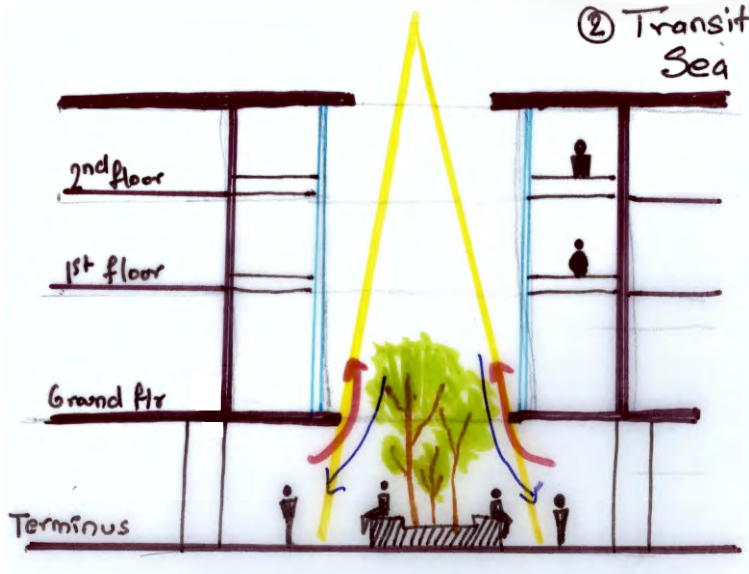
① Section at SEA

- Evapourative cooling
- Daylighting present in Corridors
- Comfortable temprature in Indoor



- Dense Bamboo plantation creates shaded areas.

② Transition spaces between Sea and Sun lounge



③ Section of Sky Cylinder.
- Exchange of fresh air in

GARDEN BY THE BAY, SINGAPORE

WHY? To study digital architecture application at urban scale projects

SITE CONTEXT

SITE PLAN

Architects: Grant Associates
Location: Bayshore Rd, SingaporeProject
Year: 2012
Manufacturers: Penetron

LEGEND

PEDESTRIAN MOVEMENT

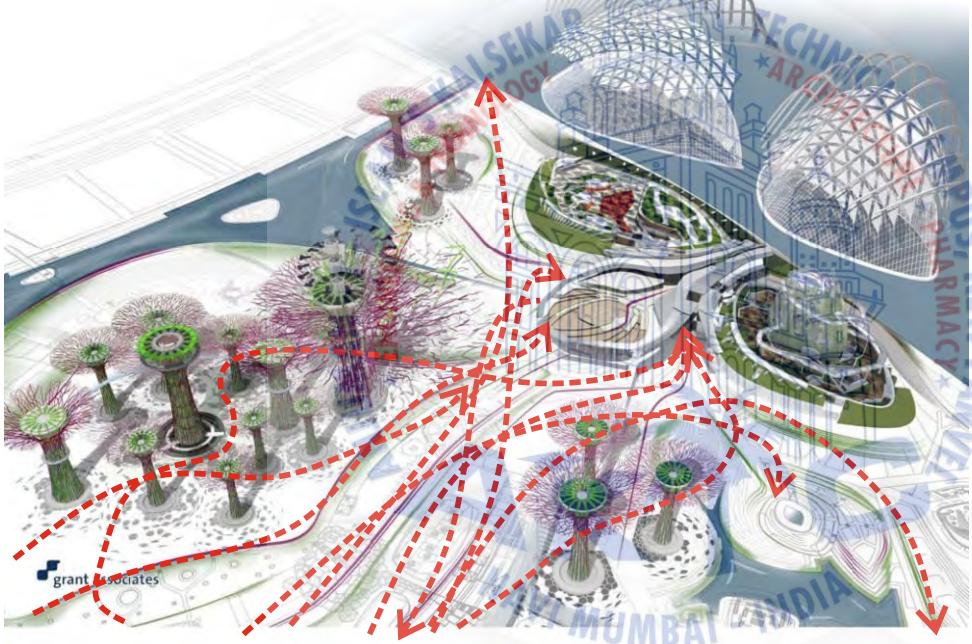


Fig. 3; *Source: Grant Associates*

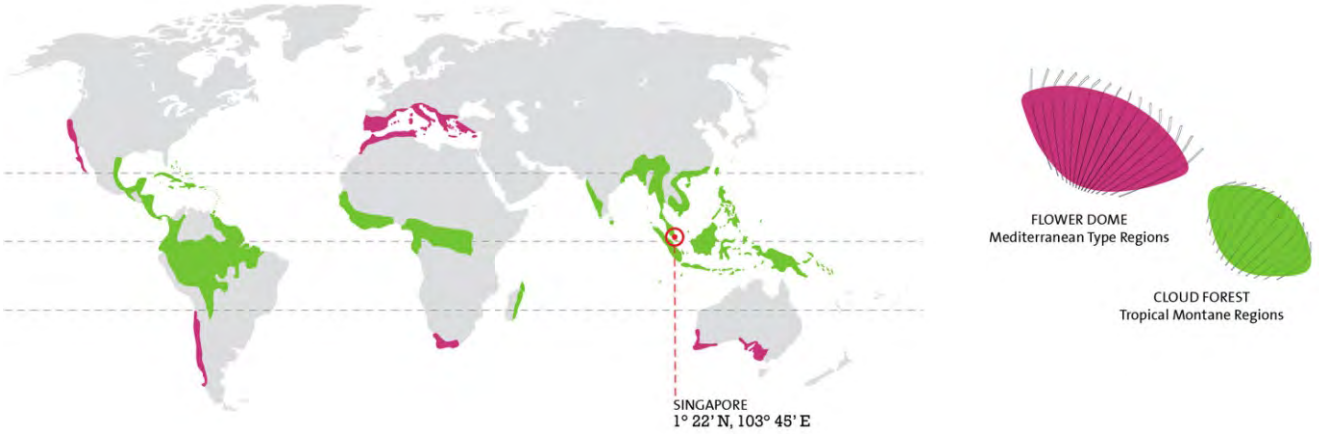
EXPLODED VIEW OF THE COOLED CONSERVATORIES

At 54 Hectares Bay South is the first and largest of three planned gardens at Gardens by the Bay in Singapore. Grant Associates has masterplanned the whole of Bay South, leading a core British design team to worldwide success. Our vision was to blend nature, technology, environmental management and imagination to create a 21st century focus for tropical horticulture and a unique destination experience.
Design details:

- 18 Supertrees (25-50m high) to act as iconic vertical gardens
- Aerial walkway and treetop bar offers unique views of the Gardens
- 2 giant Cooled Conservatories housing plants from Mediterranean and tropical Montane regions of the world
- Indoor mountain offering tropical rainforest experience
- Spectacular nightly light and sound shows
- 4 Heritage Gardens reflecting Singapore's cultural links with plants
- 6 World of Plants Gardens showcasing the biodiversity of plant life on our planet
- Dragonfly Lake and Dragonfly Bridge
- Numerous sculptures and architectural structures
- Intelligent environmental infrastructure

Powered sustainably via horticultural waste, efficient de-humification and thermal stratification

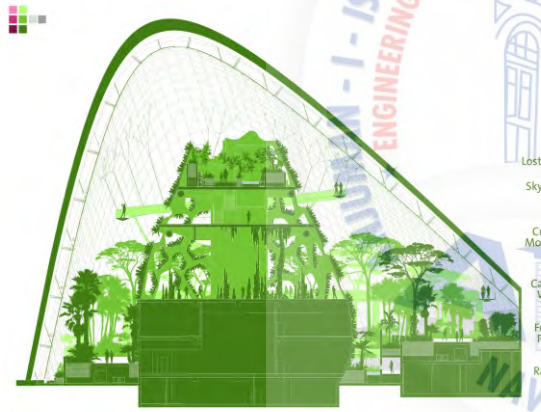
DOME CONSISTS OF FLORA AND FAUNA FROM AROUND THE WORLD



The two Cooled Conservatories at Gardens by the Bay offer a spectacular visual and spatial experience for visitors, telling the story of plants in all-weather 'edutainment spaces'.

Created by a collaborative design team led by Grant Associates, the Flower Dome and the Cloud Forest combine stunning architecture by Wilkinson Eyre Architects, ingenious structural and environmental engineering by Atelier One and Atelier Ten, innovative interpretation by Land Design Studio, striking branding and signage by Thomas Matthews and visionary landscape design with planting procured by the Gardens by the Bay horticultural team.

They work in harmony with the Supertrees, both visually and environmentally, acting as centrepiece destinations within the Gardens.



SECTION OF CLOUD FOREST DOME
SPAN : 60 M HEIGHT : 40 M

Design details:

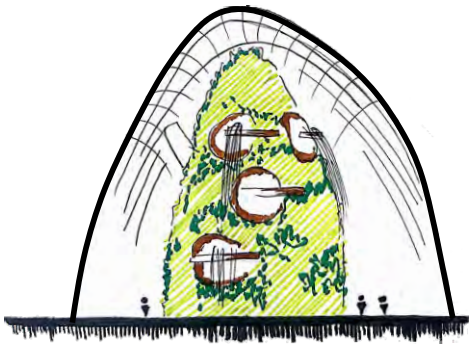
- Cooled Conservatories house 226,000 plants from every continent except Antarctica
- 1.2 hectare Flower Dome replicates a cool-dry Mediterranean climate
- Giant flower field with changing seasonal displays
- Raised walkways to explore exotic planting
- 0.8 hectare Cloud Forest recreates cool-moist climates of Tropical Montane regions
- 35 metre high epiphyte clad mountain with waterfall
- The Mountain houses galleries and a black box media exhibition themed around climate change and habitat loss

Powered sustainably via horticultural waste, efficient de-humification and thermal stratification

SECTION OF FLOWER DOME
SPAN : 90 M HEIGHT : 25 M

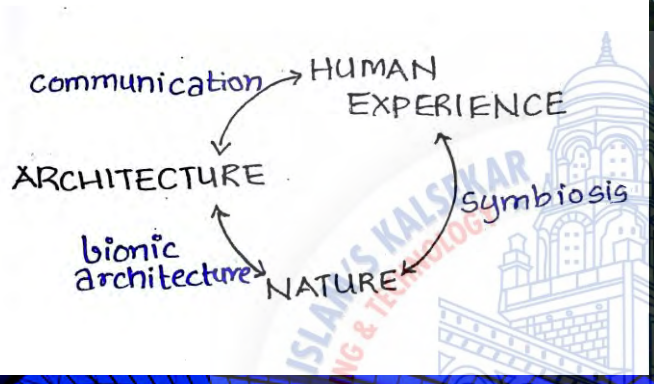
Fig. 4; *Source:* *Grant Associates*

INSIDE CLOUD FOREST DOME

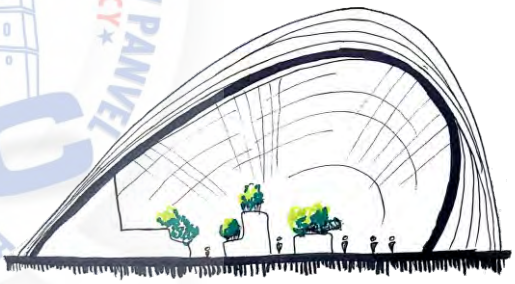


Lights and Experiences

INSIDE CLOUD FOREST DOME



INSIDE FLOWER DOME
EXPERIENCES IN THE CAMPUS



Scale and Proportion

Blend of Bionic and Digital architecture

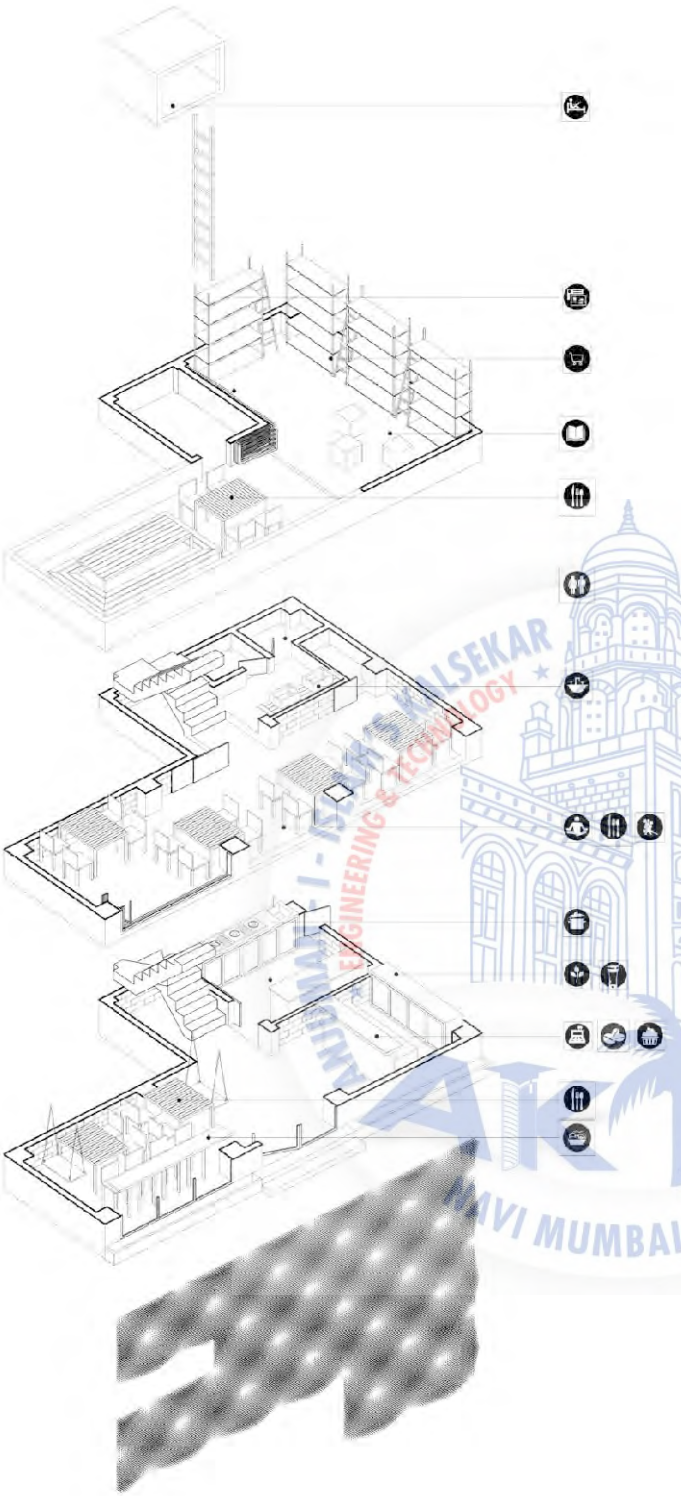
AERIAL VIEW OF GARDENS BY THE BAY

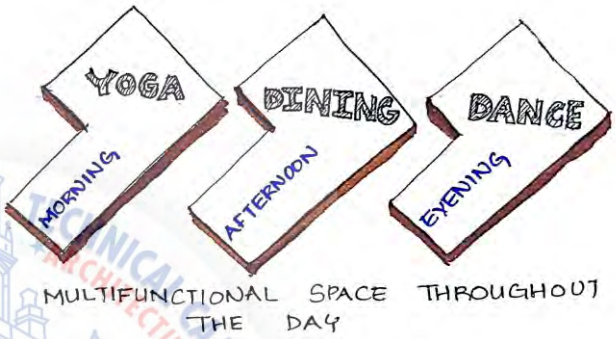
Fig. 4; *Source:* *Grant Associates*

BAD CAFÉ, BANDRA, MUMBAI

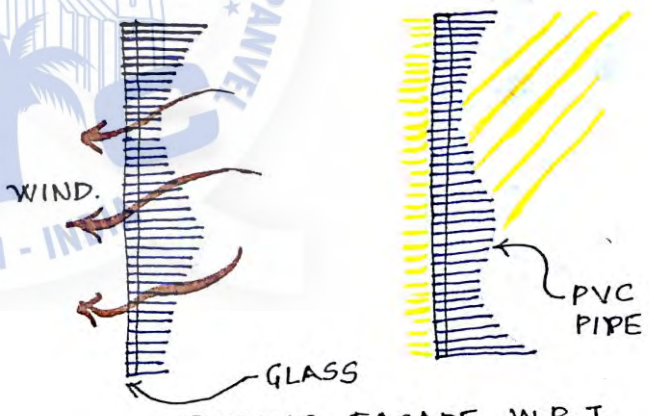
WHY? To study digital architecture application at small scale project

Client : BAD CAFÉ
Location : Bandra West, Mumbai
Type : Hospitality
Status : Completed
Architects: Nudes
Architect in Charge: Nuru Karim
Area: 3250.0 SQ.FT
Project Year : 2015

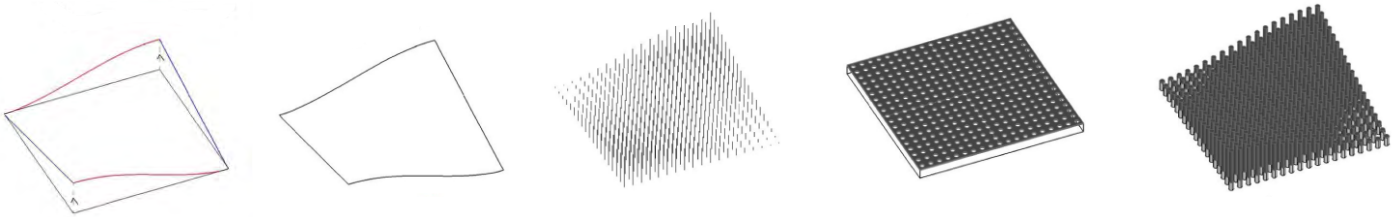




MULTIFUNCTIONAL SPACE THROUGHOUT THE DAY



POROUS FACADE W.R.T. WIND AND LIGHT



Development of facade ---------->

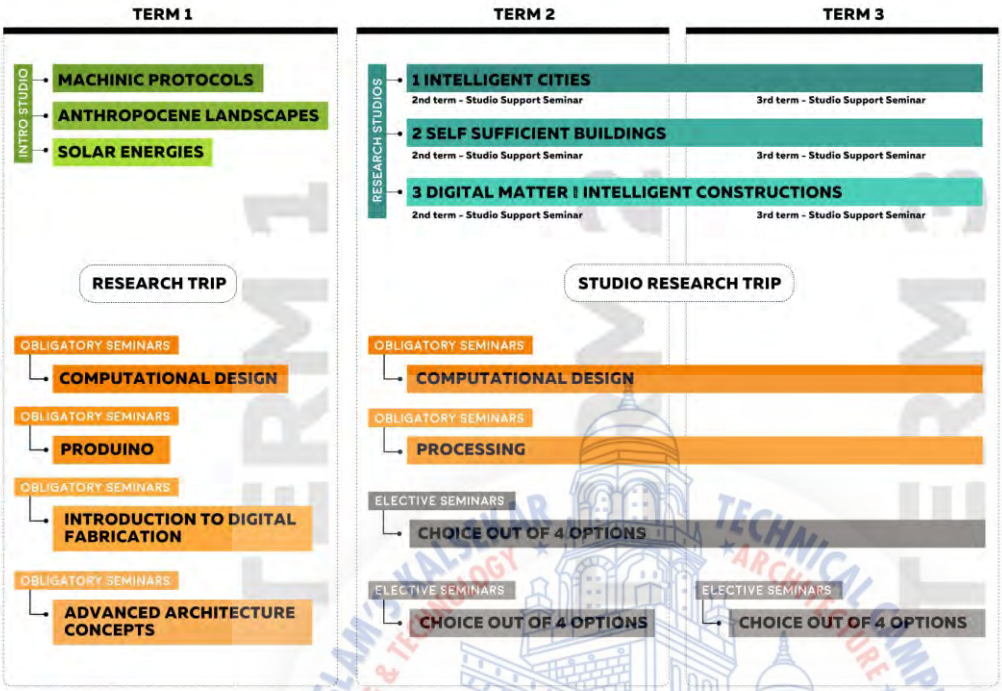
IAAC, BARCELONA
MASTERS IN ADVANCED ARCHITECTURE

WHY? To analyse and improve the current course module

MAA - MASTER IN ADVANCED ARCHITECTURE

FIRST YEAR
OCTOBER - JUNE

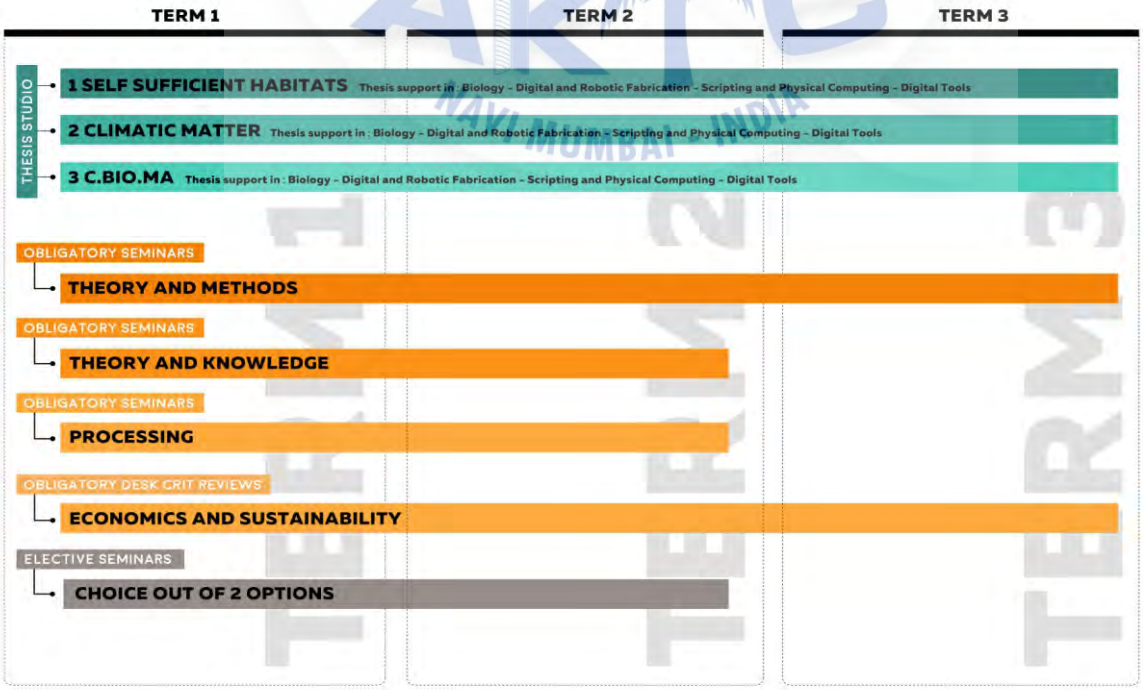
Course Module



The following program refers to the Academic Year 2016-2017.
The program for the Academic Year 2017-2018 may be subject to slight variations

MAA - MASTER IN ADVANCED ARCHITECTURE

SECOND YEAR
OCTOBER - JUNE



The following program refers to the Academic Year 2016-2017.
The program for the Academic Year 2016-2019 may be subject to slight variations

MASTERS IN ADVANCED ARCHITECTURE

- It started in 2011
- They have 2 fabrication labs
- 1. Fab lab Area: 2000 sq.m
- It consists of an auditorium for 75 seats, a warehouse for large events and classrooms.
- 2. Green fab lab
- It works towards the creation of a self-sufficient habitat and research centre at Can Valldaura, one of IAAC's campus locations.

EQUIPMENTS AVAILABLE IN FAB LAB

– Large scale laser cutter Multicamm 2000
– Large scale milling machine – 3 axis Precix 11100 Series
– Large scale milling machine – 3 axis ShopBot
– Precision milling machine Monofab ARM 10
– Vinyl cutter GX-24 Camm Servo
– Laser cutter Epilog XT Legend 36 75w
– Laser cutter Trotec Speedy 400
– Laser cutter Trotec Speedy 100
– 3D printer Zcorp Z510
– 3D printer MakerBot
– 3D printer Formlabs
– Janome digital embroidery machine
– 6 axis robotic arm – Kuka Robots

EQUIPMENTS AVAILABLE IN GREEN FAB LAB

– Abb Robotic Arm
– Laserpro
– Roland Modela
– Roland Vinyl Cutter
– Ultimaker 2
– Shopbot
– Electronic Prototyping Suite
– Roland Monofab

NATIONAL INSTITUTE OF DESIGN, AHMEDABAD

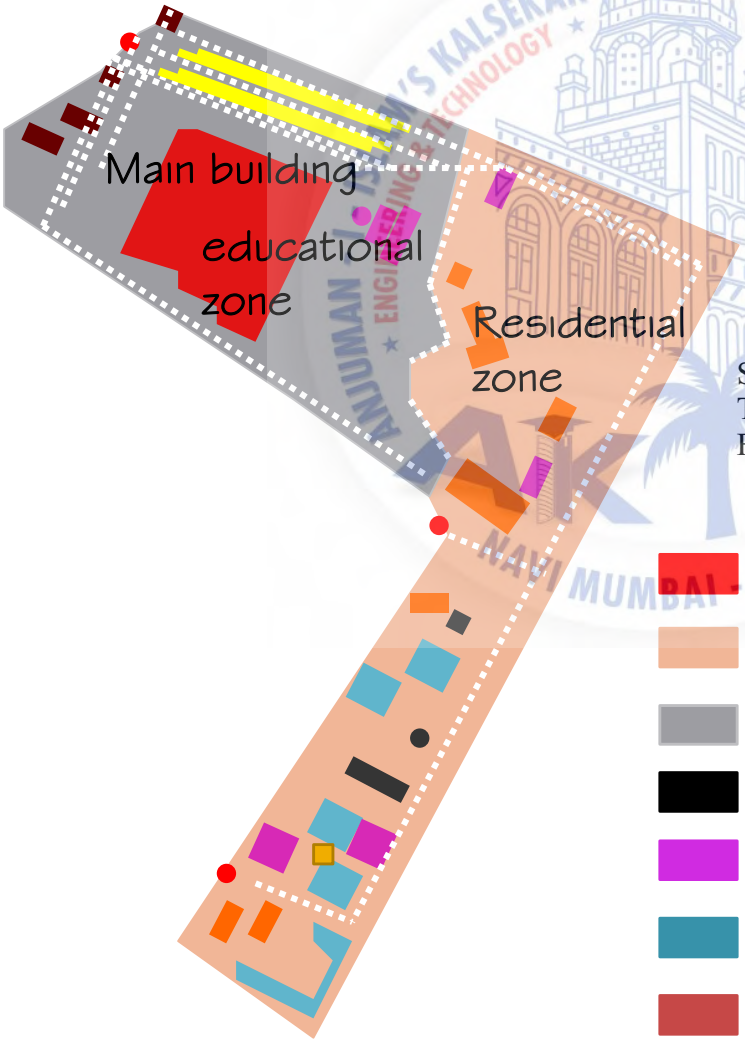
WHY? To study good design school campus for space planning

Client: Ministry Of Industry, Government Of India
Stakeholders: Faculty, Students
Total Site Area: 63,848 sq.m
Architect: Giraben Sarabhai & Charles Eames

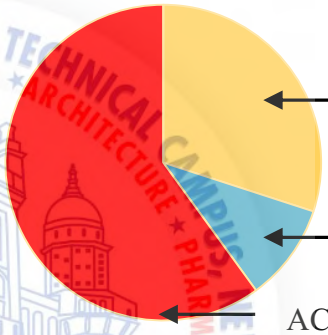
LEGEND

- GOVERNMENT BUILDINGS
- COMMERCIAL ZONE
- RESIDENTIAL ZONE
- SABARMATI RIVER

SITE PLAN



MASSING ON SITE PLAN



RESIDENTIAL 2400 SQM

ADMINISTRATION 400 SQM

ACADEMIC BLOCK 4200 SQM

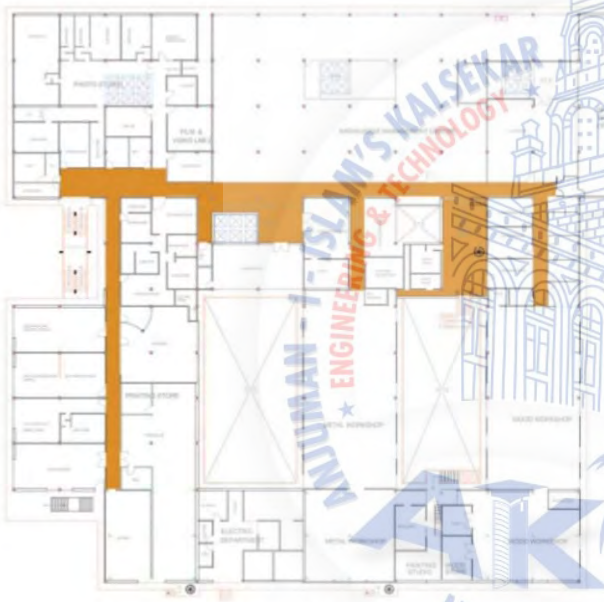
SITE AREA: 63,848 sq.m
TOTAL BUILT-UP AREA: 27,488 sq.m
FSI: 0.4

LEGEND

- MAIN BUILDING-15000 sq.m
- RESIDENTIAL ZONE-34770 sq.m
- EDUCATIONAL ZONE-29078sq.m
- SERVICES-1985sq.m
- RECREATION
- HOSTEL-7174sq.m
- STAFF QTRS
- SECURITY/ OFFICE
- PARKING
- ENTRY-3 nos.

CIRCULATION

WALKING PATHS

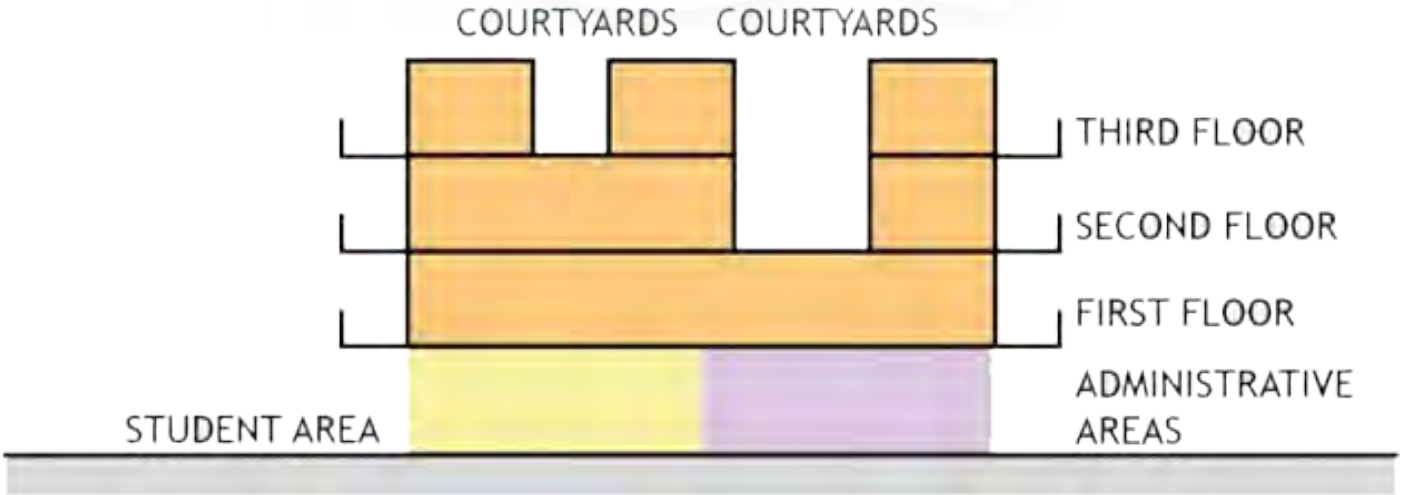


FIRST FLOOR

- Emphasis has been given on the pedestrian movement of the site.
- Vehicular movement is restricted.
- Horizontal circulation: The movement pattern develops on the ground floor through the court like spaces that developed under the structural grid.

FEATURES OF THE BUILDING

- Lawns are not only a feature of landscape but they act as interactive spaces which are used for informal gathering, cultural program, etc.
- Winds from the riverside are captured in the studios and workshops from the terraces due to adjustable glazing. Features like water bodies with jallis are used to filter the cooled air flowing over the water and passed in interiors.
- The campus has been designed taking into consideration the hot and dry climate of Ahmedabad. The activities are so planned that they spill over into inward looking spaces.
- The courtyards remain in the shadow for most part of the day. To allow the inflow of light into the workshops, sliding panels have been installed which run from the height of the skirting to about 10’ from the floor level.
- Pockets of vegetation blend with the structure on the exterior as well as interior. Large trees protect the building from surface glazing and courtyards from excessive heating.

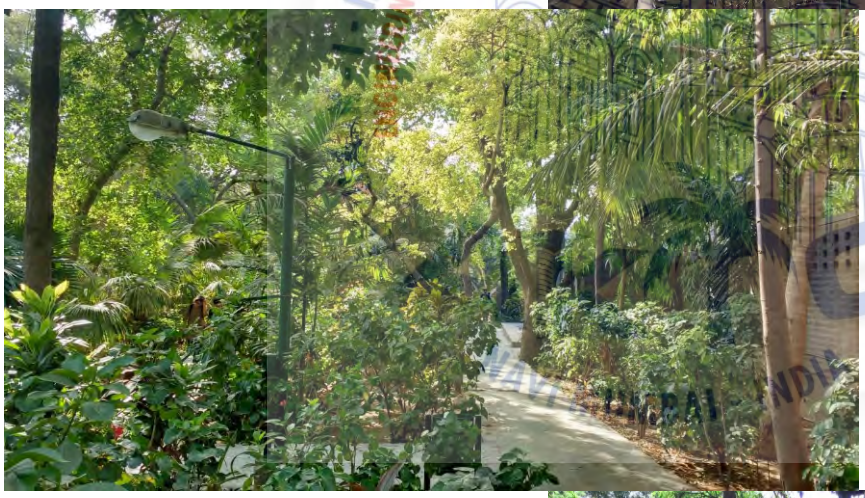


SCHEMATIC SECTION

Fig. 5; *Source: Slideshare*

LANDSCAPE BLENDING
WITH BUILT FORM

VIEW FROM THE STUDIO



SHADED PATHWAY LEADING
TO NID FROM HOSTEL

SCALE AND PROPORTION

NATURALLY
SHADED PATHWAYS

Fig. 6; *Source: NID Official Website*

INFERENCES OF CASE STUDIES

1. Maker's Asylum, Mumbai (Live Case study)

- Area:560 sq.m
- Space V/s Functionality : ✓
- Research area needs a buffer zone before entering the fab lab
- Proper ventilation/Exhuast needed in Fab Lab
- Ergonomics of Machines
- Optimum usage of space

2.BNCA,Pune (Live Case study)

- Area of Studio: 78 sq.m
- Area of Fab Lab: 76 sq.m
- Teaching module
- Space v/s Functionality: ✕
- Only Fab lab in India used for institutional use
- Dark Studios-No light and Ventilation

3.Suzlon One Earth, Pune (Live Case study)

- Area: 42087 sq.m
- Sustainable Strategies to design climate responsive design
- Recycling of waste in site
- Ductless parking lot(in Basement)
- Form & Orientation
- Space v/s Functionality: ✓

4. Gardens by the bay, Singapore (Book Case study)

- Area: 250 Acres
- To study digital Architecture application at urban scale project
- Amalgamation of Digital architecture and Bionic Architecture
- How is public circulation in exhibition area
- Space v/s Functionality: ✓

5.Bad café, Mumbai (Book Case study)

- Area : 300 sq.m
- How dynamic facades create a vibrant experience in café.
- How digital architecture can intervene at small scale project.
- Muilt-functional areas in axillary spaces.
- Space v/s Functionality: ✓

6. IAAC, Barcelona

- Area of Fab lab: 2000 sq.m
- Area of green fab lab: 1000 sq.m
- Space v/s Functionality: –
- Course Module

7. National academy of design, Ahemdabad

- Area: 63484 sq.m
- Space v/s Functionality: ✓
- Campus Development
- Buffer spaces
- Relation of built v/s open

8. Comparative analysis between different course module.

Institute For Research And Development
In
Digital Architecture

Primary Program

Research lab Fabrication lab Execution area

Digital library Simulation room Virtual reality room

Secondary Program

Fabrication lab for public Public simulation room (cinema)

Food court Open auditorium

Axillary Spaces

Hostel Café Canteen

Buffer zones Leisure activities

Users

Artists Architects Engineers

Public Allied fields

Medical Researchers
Dj
Chef
Programmers
Fashion designer
And Many more

Chapter 5
Research Design

A collection of Guidelines and standards with prospects of being applied in the Design Space Programme

Standards and data collection

Names of Machines	Brand	Work Area (in mm)	Materials	Applications
MULTICAM 2000	Multicam	1500mm x 3000mm	Wood (30mm), methacrylate or perspex (30mm), cardboard (40mm), paper, fabrics, non-PVC acrylics and other organic materials.	Real scale project development such as furniture, structures etc.
MILLING MACHINE– 3 AXIS PRECIX 11100 SERIES	Precix	1500mm x 3000mm x 300mm	Polyurethane foams, cork, wax, wood, MDF, soft materials that can be milled	Milling of 3-D models, full scale furniture parts, molding and casting, architectural elements, etc.
MILLING MACHINE– 3 AXIS SHOPBOT	ShopBot	4270 x 2310 x 1730 mm	Polyurethane foams, cork, wax, wood, MDF, soft materials that can be milled	Milling of 3-D models, full scale furniture parts, molding and casting, architectural elements, etc.
MILLING MACHINE MONOFAB ARM 10	Roland Monofab SRM 20	203.2 x 152.4 x 60.5 mm	Wood, plastics, HD foam, Wax, copper for circuits, etc.	Jewellery, milling wax molds, copper circuits printing , scanning three-dimensional objects, etc.
VINYL CUTTER GX-24 CAMM SERVO	Roland GX-24 camm-1 servo	Cutting length: 25 m (max) Cutting width: 50-700 mm	Vinyl, Flexible Copper Paper, Cloth, plastic sheets and other materials	Signage, cutting ?exible electronic circuits, cutting patterns, etc.
LASER CUTTER EPILOG XT LEGEND 36 75W	Epilog XT Legend 36	450mm x 950mm	Wood (5mm), methacrylate or perspex (5mm), cardboard (8mm) , paper, fabrics, non-PVC acrylics and other organic materials.	Signs, cutting pieces of models, raster, cut patterns, etc.
LASER CUTTER TROTEC SPEEDY 100	Trotec Speedy 100	610mm x 305 mm	Wood (5mm), methacrylate or perspex (5mm), cardboard (8mm) , paper, fabrics, non-PVC acrylics and other organic materials.	Signs, cutting pieces of models, raster, cut patterns, etc.

Names of Machines	Brand	Work Area (in mm)	Materials	Applications
LASER CUTTER TROTEC SPEEDY 400	Trotec Speedy 400	1000mm x 610 mm	Wood (5mm), methacrylate or perspex (5mm), cardboard (8mm) , paper, fabrics, non-PVC acrylics and other organic materials.	Signs, cutting pieces of models, raster, cut patterns, etc.
3D PRINTER FORMLABS	Formlabs	125mm x125mm x165 mm	Liquid photopolymer resin	Printing prototypes directly from 3D modeling, molding small objects, jewelry prototypes, etc.
3D PRINTER ZCORP Z510	Zcorp	200mmx250mx 350mm	Special high resolution plaster , with binder	Printing prototypes directly from 3D modeling, molding small objects, jewelry prototypes, etc. 2.3 Research design 2 Institute For Research And Development In Digital Architecture 3D
3D PRINTER MAKERBOT	MakerBot Replicator 2	285mm x 153mm x 155mm	PLA ?lament	Printing prototypes directly from 3D modeling, molding small objects, jewelry prototypes, etc.
JANOME DIGITAL EMBROIDERY MACHINE	Janome	240mm x 200mm	Vinyl, Flexible Copper Paper, Cloth, plastic sheets and other materials	Embroidery patterns on fabrics, bags, accessories, etc.
6 AXIS ROBOTIC ARM – KUKA ROBOTS	Kuka Robots			

Guidelines use for initial faces/ Research Concept

- Integration of green and digital architecture
- Incorporation of public open spaces for promoting digital architecture

Chapter 6
Site Justification

This Section incorporates the research and process for selecting a Site with comprehensive analysis of different areas. There are sub divisions on different scales to justify the scrutiny thoroughly.

City selection to execute design thesis:

Overview:

A City is a large and permanent human settlement. Cities generally have complex systems for sanitation, utilities, land usage, housing, and transportation. The concentration of development greatly facilitates interaction between people and businesses, sometimes benefiting both parties in the process, but also presenting challenges to managing urban growth. 21st century is also known as the century of cities. Almost 70% of the world's population will stay in the urban setup by 2050. Cities have a major impact on the economic and social development.

Recent statistics state that 75% of the world's resources and energy are consumed by cities and generate about 80% of the greenhouse gases.Naturally this situation demands a change with regards to the development and management for all types of infrastructure within cities. This scenario shows that urban environment with a growing demand for efficiency and resources, the government has to consider evolution and take a step forward towards sustainability. Indian cities being one of the less urbanized countries of the world with only 27.78 per cent of its population living in urban setups, our country is facing a serious crisis of urban growth at the present time. Whereas urbanization has been an instrument of economic, social and political progress, it has led to severe environmental problems. Urban sprawl is rapidly encroaching the precious agricultural and forest land. The urban population of India had already crossed the 285 million mark by 2001. By 2030, more than 50 per cent of India's population is expected to live in urban areas. To accommodate this population, there is rapid growth in the infrastructure and this is largely neglected in enduring it.

Growth of the cites v/s Pollution index

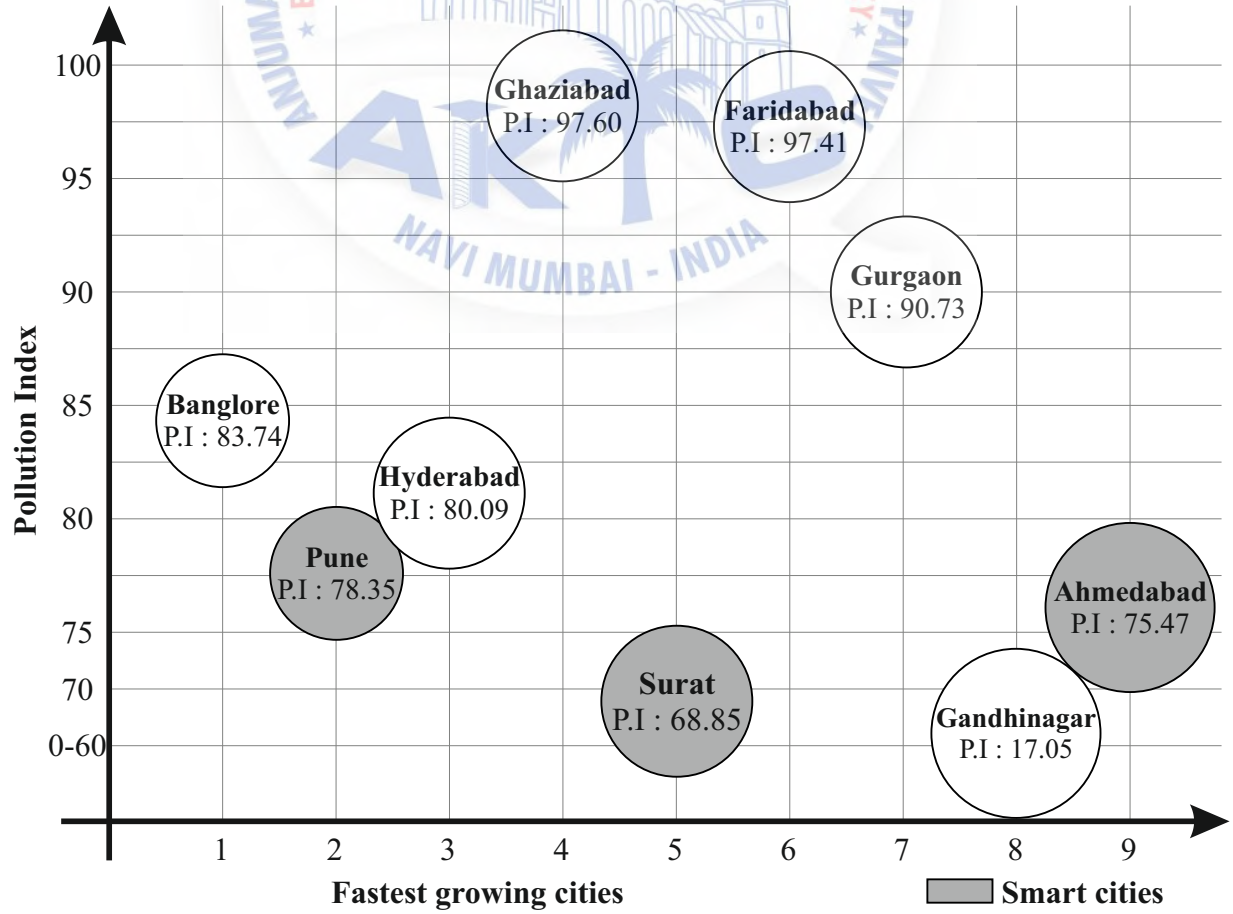


Fig.7; *Data Source:https://www.numbeo.com/pollution/rankings.jsp*
http://www.walkthroughindia.com/offbeat/top-35-fastest-developing-and-emerging-cities-of-india

This data clearly states the amount of pollution an average human faces on a daily basis. This arises the need to not just build cities, but Smart Cities. The concept of a Smart City is that investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory action of government. Making a city smart is not just about technology and connectivity. Digitalization or digital innovation had opened up tremendous potential for new ways of interaction with citizens, spaces and systems; and have become a part of a connected conversation. Digitalization has led to innovation of new forms and technologies, green architecture, eco-friendly and sustainable architecture. Though digital and green architecture are always seen in silos, these two fields combined can give great results. As an architect, I wish to make use of the digital means to create my Institution in parametric format all the while it being an excellent example of a sustainable piece of architecture.In India, the knowledge of these fields is largely exiguous. With evolving technologies digital architecture has reached the next level of excellence. The institution offers a scope to learn and to create the same.As Bjarke Ingels has rightly said that Sustainability can't be like some sort of a moral sacrifice or political dilemma or a philanthropical cause. It has to be a design challenge.It is about making different life forms possible without making a compromise on aesthetics. My institution promises of the same.

20 Smart Cities Proposed by Govt of India

1. Bhubaneswar	11. Indore
2. Pune	12. NDMC
3. Jaipur	13. Coimbatore
4. Surat	14. Kakinada
5. Kochi	15. Belagavi
6. Ahmedabad	16. Udaipur
7. Jabalpur	17. Guwahati
8. Visakhapatnam	18. Chennai
9. Solapur	19. Ludhiana
10. Davanagere	20. Bhopal

Source:http://smartcities.gov.in/content/innerpage/cities-profile-of-20-smart-cities.php

Inference:

If we compare these cities, Pune has better scope for this research as it is a Learning and technology hub. This research can act as an prototype to replicate in all other cities

Chapter 6.1
Emerging cities of Maharashtra

An outline of different emerging cities with scope of promoting and executing digital architecture on an optimum level.

Emerging cities of Maharashtra

Pune city has emerged as a major educational and IT hub. The city ranked second in India in terms of quality of living in 2017 and also second fastest growing cities in the Asia-Pacific region.

Lets compare the emerging cities of Maharastra

Pune v/s Mumbai v/s Navi Mumbai on the basis of

- Educational hub
- Topography
- Connectivity
- Transportation

1.Educational hub

According to an article on http://timesofindia.indiatimes.com

With 811 colleges, Pune varsity 2nd largest in country

Hemali Chhapia | TNN | Nov 4, 2013.

Fig.8; *Source: http://timesofindia.indiatimes.com/home/education/news/With-811-colleges-Pune-varsity- 2nd-largest-in-country/articleshow/25196438.cms*

University	Affiliated colleges
Osmania University, Hyderabad	901
Pune University, Pune	**811**
Nagpur University, Maharastra	800
Rajasthan University, Jaipur	735
Mumbai University	**171**

Inference: According to source: https://collegedunia.com/architecture/navi-mumbai-colleges?city_id=336

Total number of affiliated colleges for architecture in respective cities

Mumbai- 17

Navi Mumbai- 7

Pune-21

But Masters in digital architecture is only taught in 2 institutes and both are in Pune.

Institutes where digital architecture is taught

BNCA, PUNE - Master In Digital Architecture

SINHAGAD COA, PUNE - Masters In Computer Applications

IAAC, BARCELONA - Masters in Advanced Architecture

- Masters in Advanced Interaction

ELISAVA escola de diseño, Barcelona - Masters in Advanced Architecture

Universitat Internacional de Catalunya (UIC), Barcelona - Masters in Biodigital Architecture

AA SCHOOL OF LONDON- Masters in Emergent Technologies

Sciarc, Los Angeles, California - Masters in Advanced Architecture (Ma001)

University of Nottingham - Masters in Digital Architecture and Tectonics

2. Topography

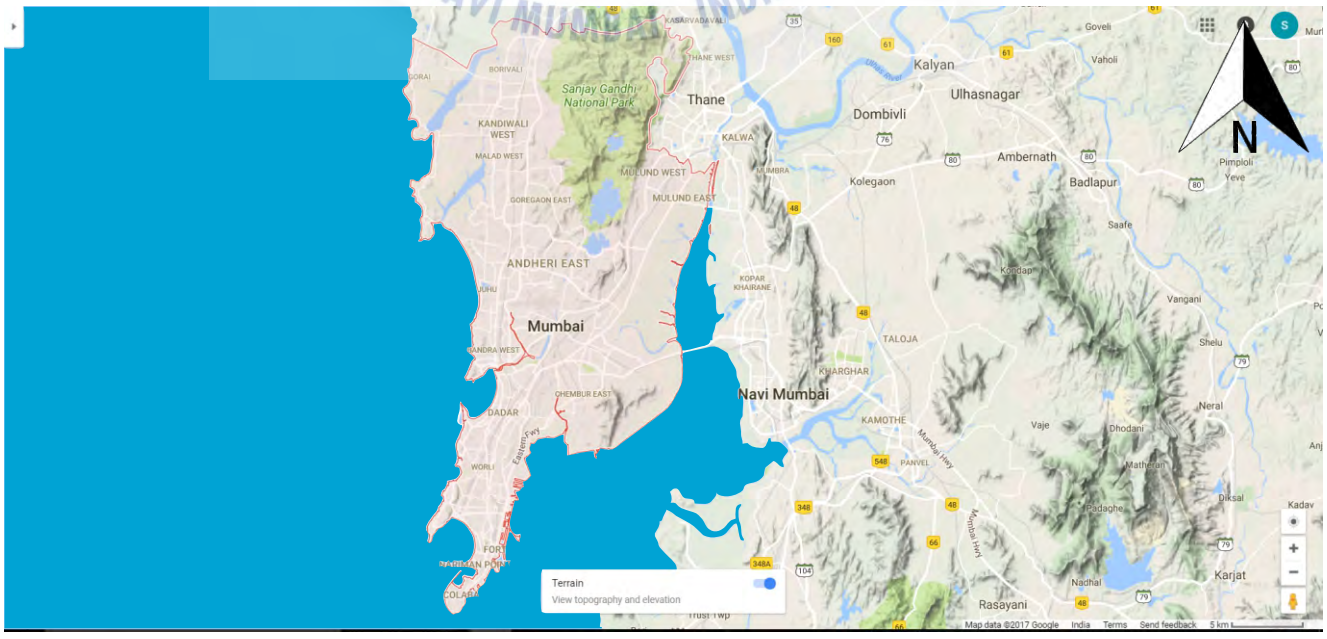
Pune

- Pune has a more organic urban spread where it is growing from the centre spreading outwards.
- It has more land availability for future development as compared to mumbai and navi mumbai.

Source: Google maps

Mumbai

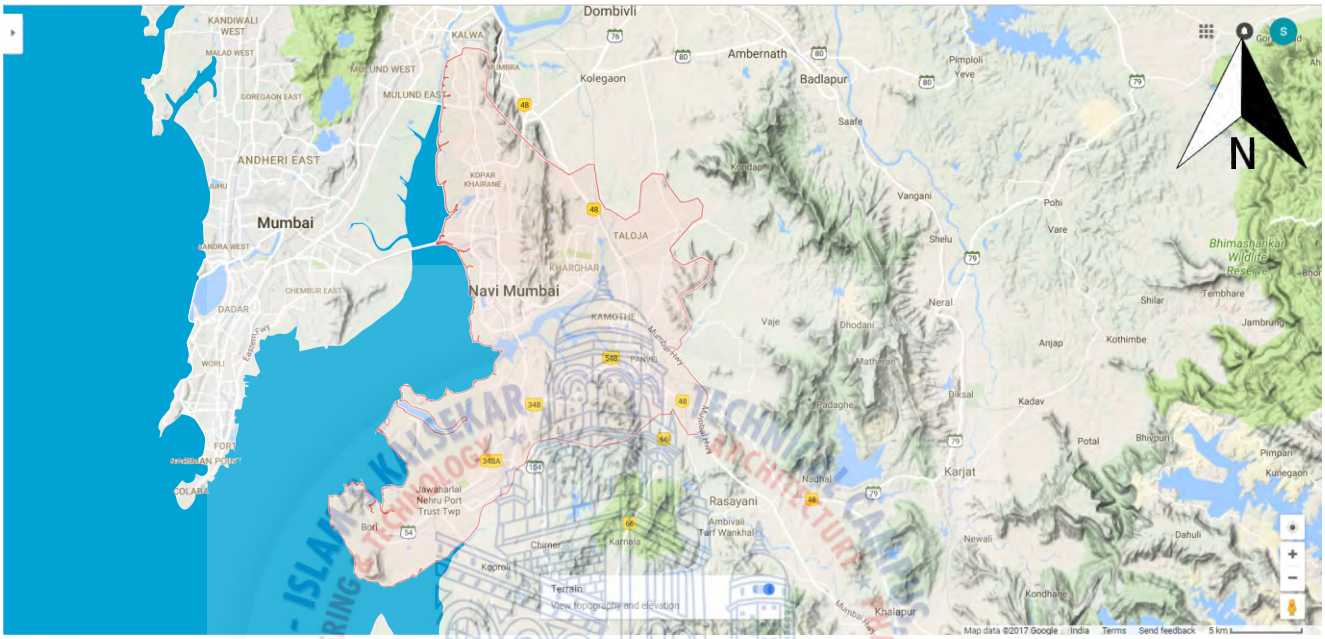
- Mumbai has a more linear urban spread where it is growing from south and spreading on north and eastern side
- It has less land availability for future development as compared to Pune and navi mumbai.
- It is a economic capital on india but it is going under decongestion as it is over-exploding and has scarcity for resources

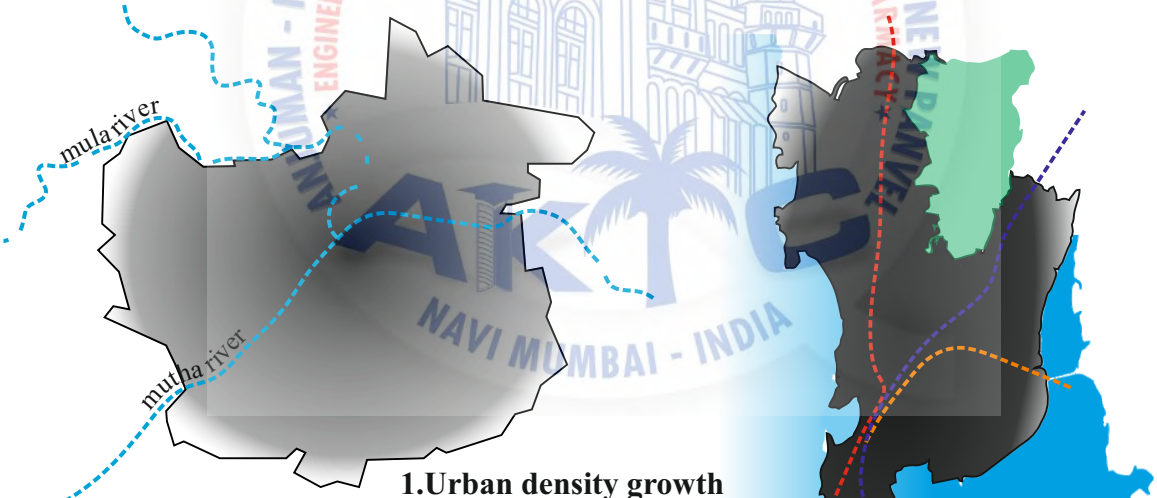


Source: Google maps

Navi mumbai

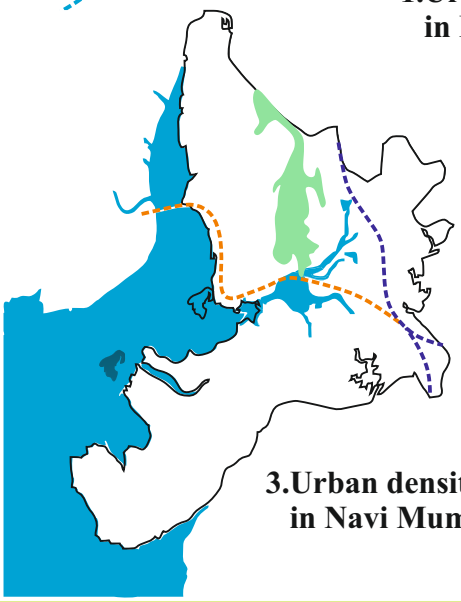
- Navi mumbai has been growing more towards north but away from the railway line
- The main urban development focus is more towards decongesting mumbai, so it has more number for residential zone
- But in terms of connectivity railway line is on one side and the city is growing on the other side, hence it is a major drawback





1.Urban density growth in Pune

2.Urban density growth in Mumbai



3.Urban density growth in Navi Mumbai

Legend

- Denseness of development
- Railway line
- River
- Water bodies
- City limit

2. Connectivity & Transportation

Pune

- Pune has only **B.R.T.S System** as public transportation system.
- **Metro** is being proposed in pune city and will be completed by 2021
- There are **more** number **of 2-wheelers** in the city as compared to other cities
- It has train services which connect Pune to other cities but the main station of Pune is in the heart of the city and it is very far from the city outskirts. People need to travel approx 1-2hrs depending on traffic to reach to station
- It has National Highway which connects pune to other nearby cities.
- One **NH 60** connects Dhule and Pune in the state of Maharashtra
- **NH 65** starts at Pune and ends at Machilipatnam, Andhra Pradesh. It runs along the states of Maharashtra, Karnataka, Telangana and Andhra Pradesh.
- Other **NH 48** connects Delhi and Bengaluru via Mumbai and Pune.
- **Pune airport** handles both domestic and international flights with approx Passenger movements 6,787,391 and Aircraft movements 46,932 yearly.

Mumbai

- The number of private cars more than 9 lakh- 45% increase over five years.
- As for two-wheelers- 17 lakh.
- **Buses** at a frequency of around 80 buses per hour on a stretch (ferrying 4,000 commuters).

Source: Number of vehicles in Mumbai up 50% in 5 years | TNN | Jan 3, 2017
Http://timesofindia.indiatimes.com/city/mumbai/no-of-vehicles-in-city-up-50-in-5-yrs/articleshow/56302918.cms

- It also has 3 **intercity railway lines- Central, Western and Harbour railway line**, which provide good connectivity for the public to reach in different parts of the city.
- It has **metro** which gives east west connectivity and **monorail** which connects different smaller fragments for the city. I.e Waldala- Chembur.
- It has many Trains which connect to other cities running almost daily
- **Mumbai airport** handles both domestic and international flights with approx Passenger movements 45,154,345 and Aircraft movements 305,465 yearly.

Navi Mumbai

- Navi mumbai has harbour railway line as its major public transportation system and but it is location on the one side and the urban development is happening on the other side.
- Interior parts are connected by buses which are an alternative to rickshaws in the city.
- From belapur to kharghar, a metro is under construction to give faster connectivity to the users into the interior parts of kharghar.
- Navi Mumbai airport is being proposed to decongest the Mumbai airport which is still under proposal stage.

Comparing Pune v/s Mumbai v/s Navi Mumbai on basis of

1. Pollution 2. Traffic 3. Quality of life

Fig. 9; *Source: https://www.numbeo.com/quality-of-life/comparison.jsp*

Pollution

Index	Pune	Mumbai	Navi Mumbai
Pollution Index:	79.82	86.48	72.16
Pollution Exp Scale:	141.13	154.32	127.27

Air pollution data from World Health Organization

	Pune	Mumbai	Navi Mumbai
PM_{10}	92	117	120
$PM_{2.5}$	49	63	64
PM_{10} Pollution Level:	High	Very High	Very High

Pollution Pune vs Mumbai

	Pune (Improve Data)	Mumbai (Improve Data)	Navi Mumbai (Improve Data)
Air Pollution	High 69.87	High 77.62	High 68.64
Drinking Water Pollution and Inaccessibility	Moderate 54.77	High 60.00	Moderate 44.39
Dissatisfaction with Garbage Disposal	High 71.53	High 76.20	High 62.75
Dirty and Untidy	High 68.92	High 78.95	Moderate 54.81
Noise and Light Pollution	High 70.23	High 71.68	Moderate 54.89
Water Pollution	High 77.95	High 77.13	High 68.23
Dissatisfaction to Spend Time in the City	High 65.49	High 71.43	High 60.53
Dissatisfaction with Green and Parks in the City	High 61.14	High 66.63	Moderate 47.06
Contributors:	*120*	*241*	*60*
Last Update:	*August 2017*	*September 2017*	*September 2017*

	Pune (Improve Data)	Mumbai (Improve Data)	Navi Mumbai (Improve Data)
Air quality	Low 30.13	Low 22.38	Low 31.36
Drinking Water Quality and Accessibility	Moderate 45.23	Moderate 40.00	Moderate 55.61
Garbage Disposal Satisfaction	Low 28.47	Low 23.80	Low 37.25
Clean and Tidy	Low 31.08	Low 21.05	Moderate 45.19
Quiet and No Problem with Night Lights	Low 29.77	Low 28.32	Moderate 45.11
Water Quality	Low 22.05	Low 22.87	Low 31.77
Comfortable to Spend Time in the City	Low 34.51	Low 28.57	Low 39.47
Quality of Green and Parks	Low 38.86	Low 33.37	Moderate 52.94
Contributors:	*120*	*241*	*60*
Last Update:	*August 2017*	*September 2017*	*September 2017*

Quality of life

Index	Pune	Mumbai	Navi Mumbai
Quality of Life Index:	123.20	82.16	129.11

	Pune		Mumbai		Navi Mumbai	
Purchasing Power Index	Moderate	87.99	Moderate	67.24	Moderate	74.45
Safety Index	Moderate	57.13	Moderate	54.61	High	71.77
Health Care Index	High	64.18	High	63.93	High	74.20
Climate Index	High	74.32	High	71.48	High	71.94
Cost of Living Index	Very Low	29.61	Very Low	32.23	Very Low	28.75
Property Price to Income Ratio	Moderate	8.60	Very High	28.26	High	13.11
Traffic Commute Time Index	High	46.54	High	58.15	High	46.50
Pollution Index	High	79.82	Very High	86.48	High	72.16
Quality of Life Index	High	123.20	Moderate	82.16	High	129.11
Minimum contributors in an underlying section:		43		74		8
Maximum contributors in an underlying section:		361		556		104
Last Update:		September 2017		September 2017		September 2017

Index	Pune	Mumbai	Navi Mumbai
Traffic Index:	205.66	272.32	204.22
Time Index (in minutes):	46.54	58.15	46.50
Time Exp. Index:	4,256.40	13,646.19	4,233.89
Inefficiency Index:	221.59	272.12	170.01
CO_2 Emission Index:	6,239.36	6,538.30	6,338.33

Improve data for Pune

Improve data for Mumbai

Main Means of Transportation

	Pune	Mumbai	Navi Mumbai
Working from Home	14.49%	10.81%	25.00%
Walking	13.04%	17.57%	0.00%
Car	43.48%	32.43%	50.00%
Bike	17.39%	6.76%	0.00%
Motorbike	5.80%	4.05%	0.00%
Bus/Trolleybus	5.80%	10.81%	12.50%
Tram/Streetcar	0.00%	1.35%	0.00%
Train/Metro	0.00%	16.22%	12.50%

Average when primary using Walking

	Pune	Mumbai	Navi Mumbai
Distance	7.53 km	8.03 km	0.00 km
Walking	60.67 min	27.85 min	0.00 min
Waiting	0.00 min	3.08 min	0.00 min
Driving Car	2.22 min	1.15 min	0.00 min
Bike	10.00 min	2.31 min	0.00 min
Motor Bike	0.00 min	0.54 min	0.00 min
Bus/Trolleybus Ride	0.00 min	2.31 min	0
Train/Metro Ride	0.00 min	7.15 min	
Overall	76.22 min	44.38 min	
Contributors	9	13	

Average when primary using Car

	Pune	Mumbai	Navi Mumbai
Distance	15.15 km	19.25 km	16.50 km
Walking	1.17 min	1.08 min	0.25 min
Waiting	0.03 min	0.00 min	0.00 min
Driving Car	40.23 min	59.29 min	32.50 min
Overall	41.60 min	60.38 min	32.75 min
Contributors	30	24	4

Average when primary using Bike

	Pune	Mumbai	Navi Mumbai
Distance	10.79 km	7.60 km	0.00 km
Bike	29.17 min	21.00 min	0.00 min
Overall	29.17 min	21.00 min	0.00 min
Contributors	12	5	0

Average when primary using Motorbike

	Pune	Mumbai	Navi Mumbai
Distance	25.25 km	6.33 km	0.00 km
Walking	2.50 min	0.67 min	0.00 min
Motor Bike	53.75 min	19.33 min	0.00 min
Overall	56.25 min	20.00 min	0.00 min
Contributors	4	3	0

Average when primary using Bus/Trolleybus

	Pune	Mumbai	Navi Mumbai
Distance	14.50 km	19.62 km	15.00 km
Walking	5.25 min	6.25 min	8.00 min
Waiting	8.75 min	15.38 min	5.00 min
Bus/Trolleybus Ride	37.75 min	58.12 min	25.00 min
Train/Metro Ride	7.50 min	3.12 min	0.00 min
Overall	59.25 min	83.50 min	38.00 min
Contributors	4	8	1

Average when primary using Tram/Streetcar

	Pune	Mumbai
Distance	0.00 km	40.00 km
Walking	0.00 min	5.00 min
Waiting	0.00 min	15.00 min
Tram/Streetcat Ride	0.00 min	30.00 min
Train/Metro Ride	0.00 min	25.00 min
Overall	0.00 min	75.00 min
Contributors	0	1

Average when primary using Train/Metro

	Pune	Mumbai

Average when primary using Train/Metro

	Pune	Mumbai	Navi Mumbai
Distance	0.00 km	23.42 km	35.00 km
Walking	0.00 min	9.67 min	10.00 min
Waiting	0.00 min	11.67 min	10.00 min
Bus/Trolleybus Ride	0.00 min	8.00 min	25.00 min
Tram/Streetcat Ride	0.00 min	0.67 min	15.00 min
Train/Metro Ride	0.00 min	40.42 min	40.00 min
Overall	0.00 min	75.33 min	110.00 min
Contributors	0	12	1

Overall Average Travel Time and Distance to Work (school)

ool)

	Pune	Mumbai	Navi Mumbai
Distance	13.74 km	16.69 km	19.33 km
Overall	46.54 min	58.15 r	46.50 min
Contributors	69	74	8
Last Update	September, 2017	September, 2017	September, 2017

Comparative Analysis:

	PUNE	MUMBAI	NAVI MUMBAI
Educational hub	1	2	3
Topography	1	3	2
Connectivity	2	1	3
Transportation	2	1	3

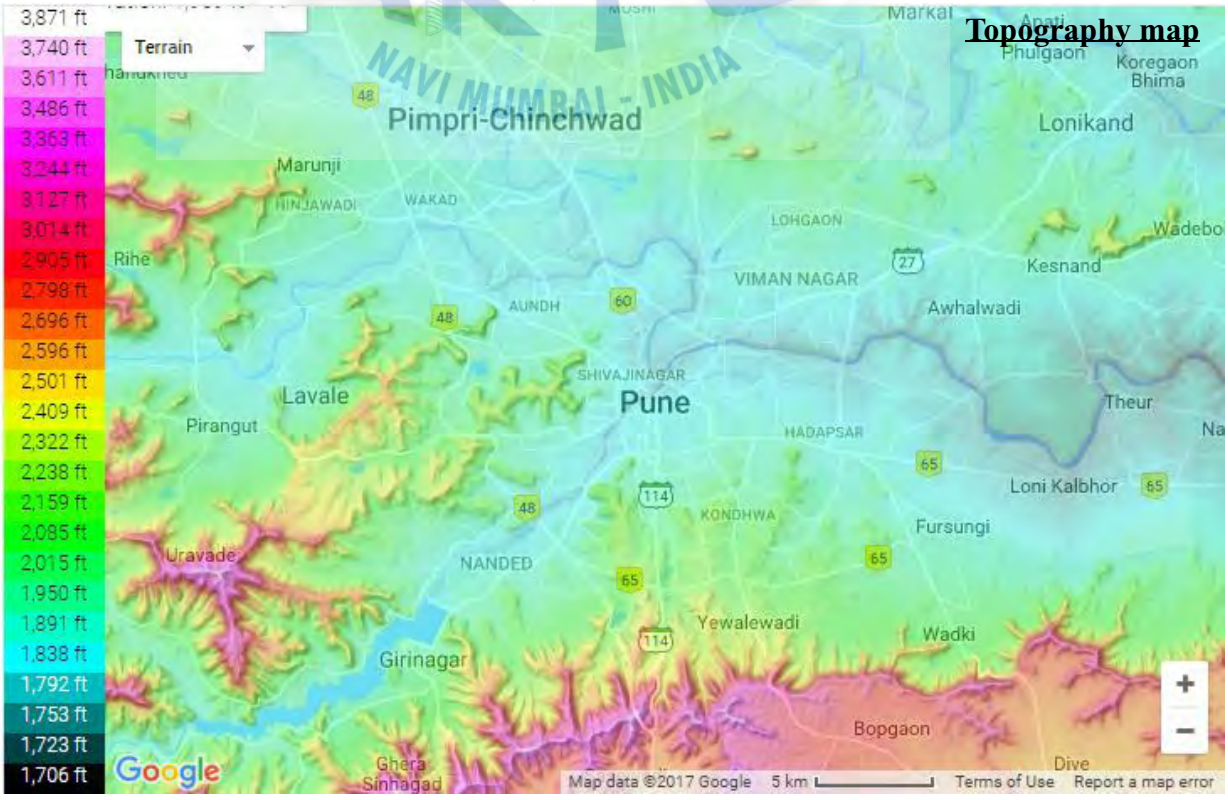
Inference: Pune is more suitable for executing the thesis proposal

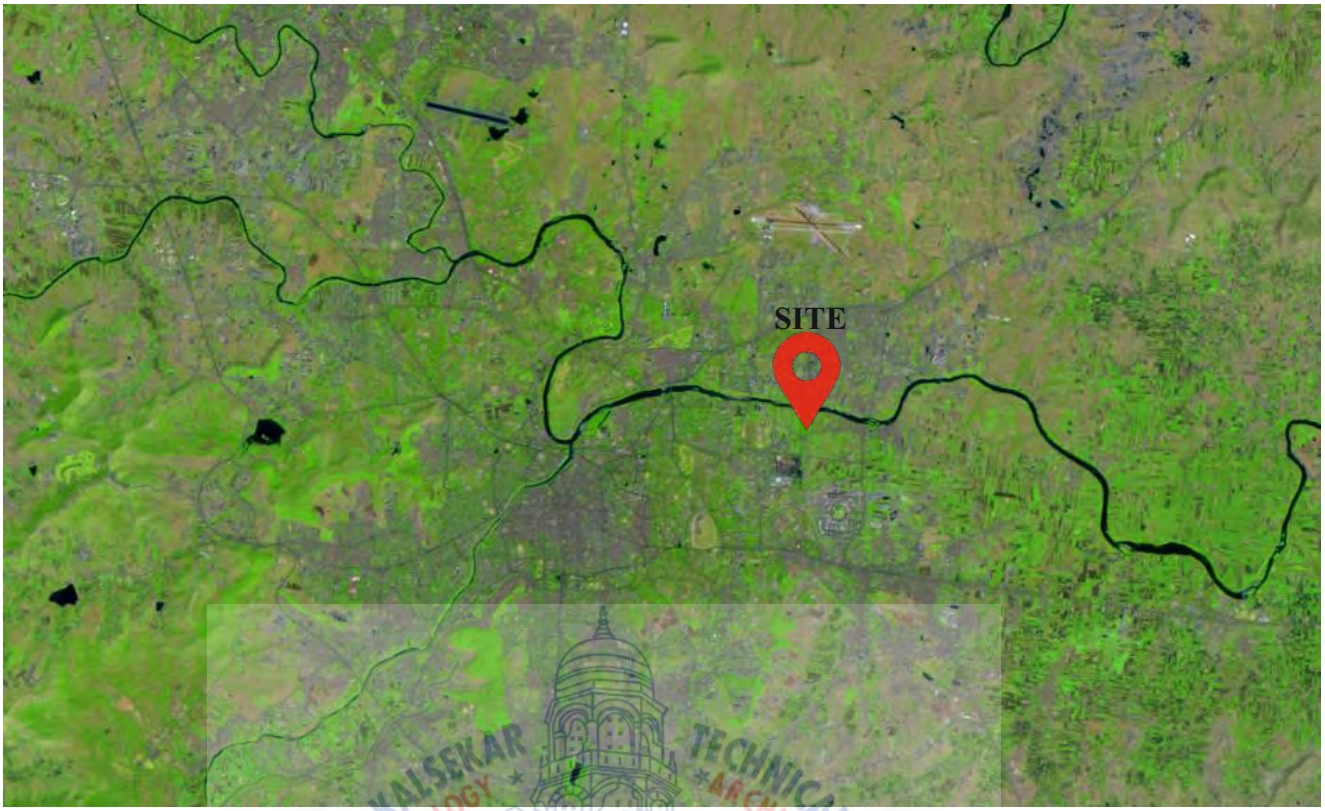
CITY: PUNE (18.5204° N, 73.8567° E)

Pune has a hot semi-arid climate bordering with tropical wet and dry with average temperatures ranging between 19 to 33 °C (66 to 91 °F).

1)**Landform:** On Southern to west side it is surrounded by mountains which go upto the height of 3800 ft high whereas the lowest is 1827 ft. From the S-W Mutha river enters the city and from N-W Mula River enters and meet at the central area of pune with Mutha river where it continues further to N-E.

Inference: The site is not much surrounded by high mountains and it is adjacent to the Mula-Mutha river which keeps flowing towards east





2)**Green v/s Built:** The image shows the green pockets surrounding Pune city.

Source:ArcGIS

Inference: The site has many open green land in the surroundings which can help in creating a cool micro-climate. The design should encourage and maintain the greens on the site to help in maintaining the micro-climate temperature.

3)Some Basic readings

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Dry Bulb Temperature (Avg Monthly)	19	21	25	28	29	26	24	23	24	24	21	19	degrees C
Dew Point Temperature (Avg Monthly)	11	9	8	11	18	21	21	21	21	20	15	11	degrees C
Relative Humidity (Avg Monthly)	61	51	39	38	55	78	84	86	83	80	70	64	percent
Wind Direction (Monthly Mode)	270	270	290	290	270	270	270	270	270	90	90	90	degrees
Wind Speed (Avg Monthly)	0	0	0	0	2	2	1	1	1	0	0	0	m/s

Fig.10; *Source:Climate Consultant*

Max reading

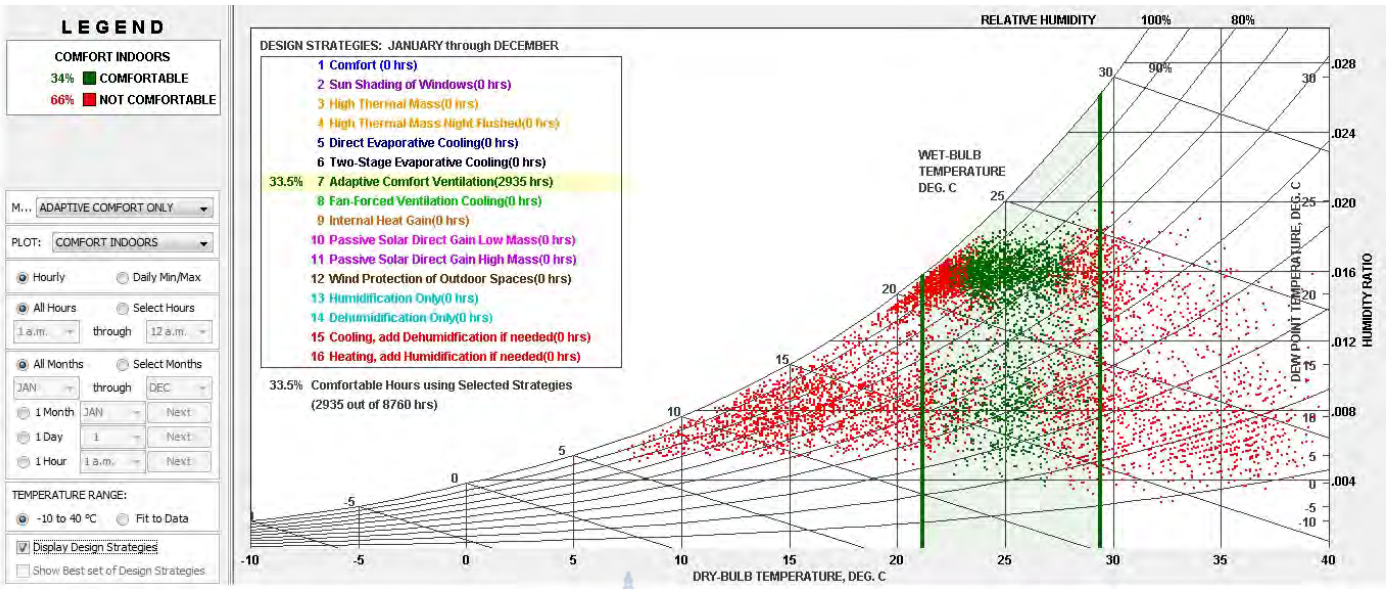
Min reading

Inference: Max temp: 29*C May Min temp: 19*C Dec- Jan

Max Relative Humidity: 21% Jun-Sept Min Relative Humidity: 38% Apr

Max Wind Speed: 8m/s coming from west

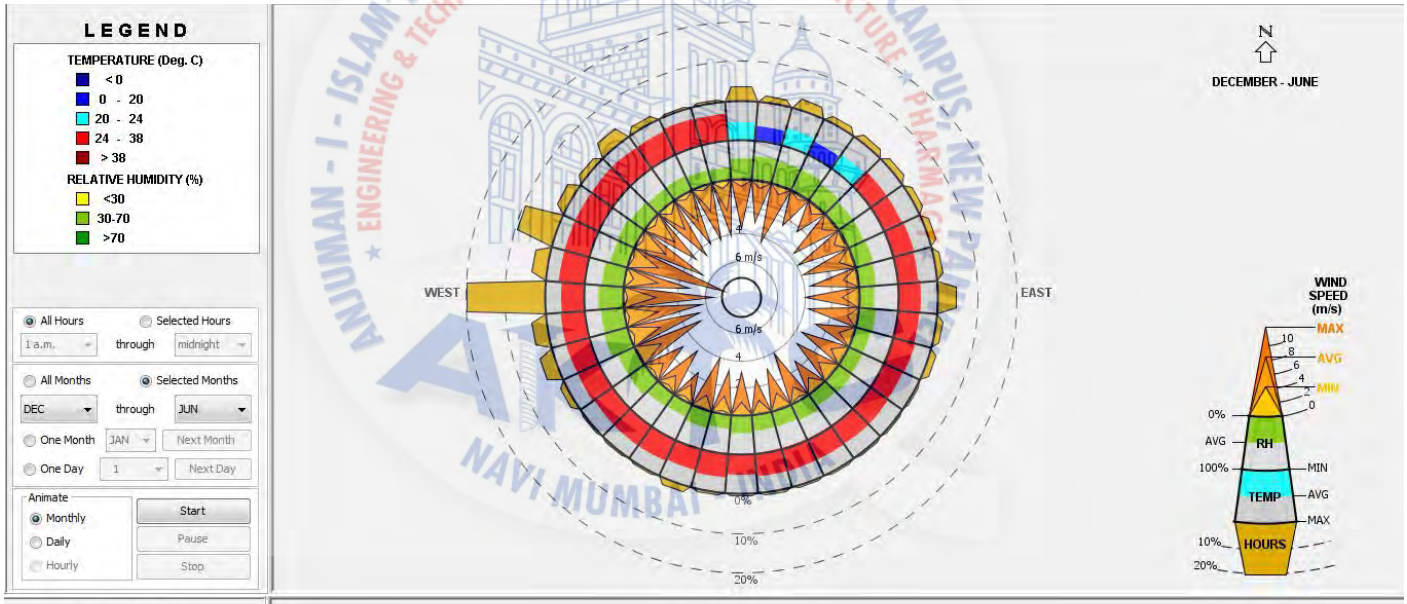
4)Bio-climatic chart

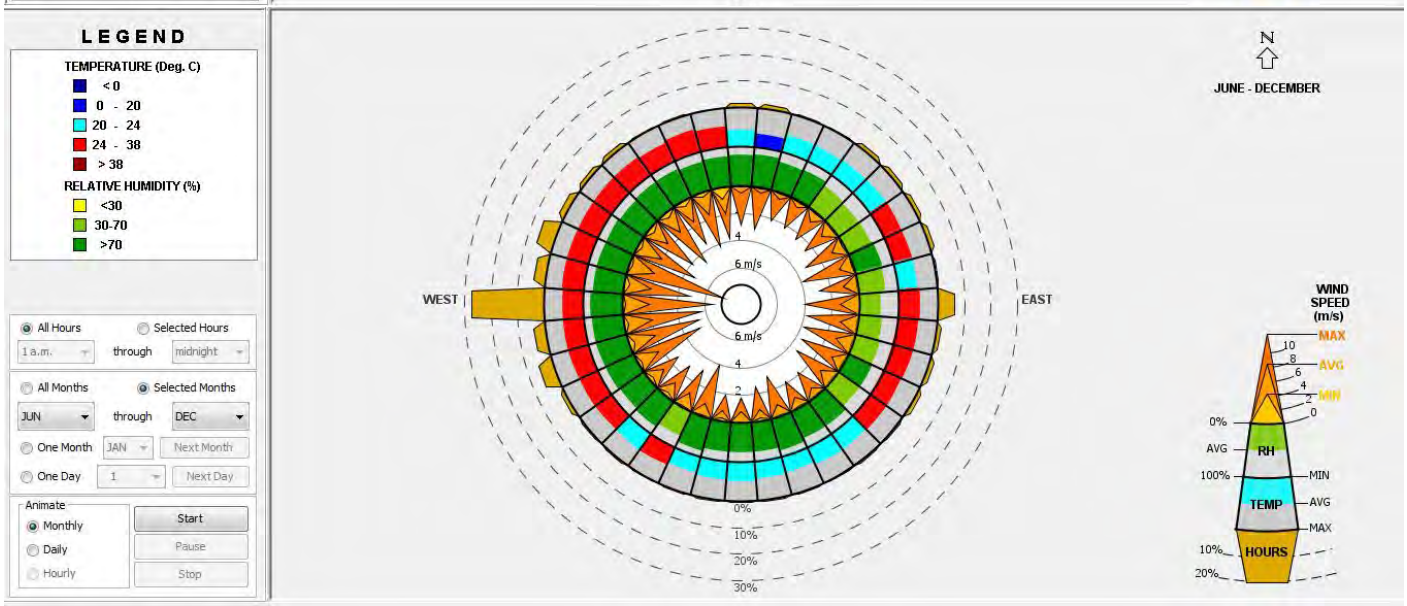


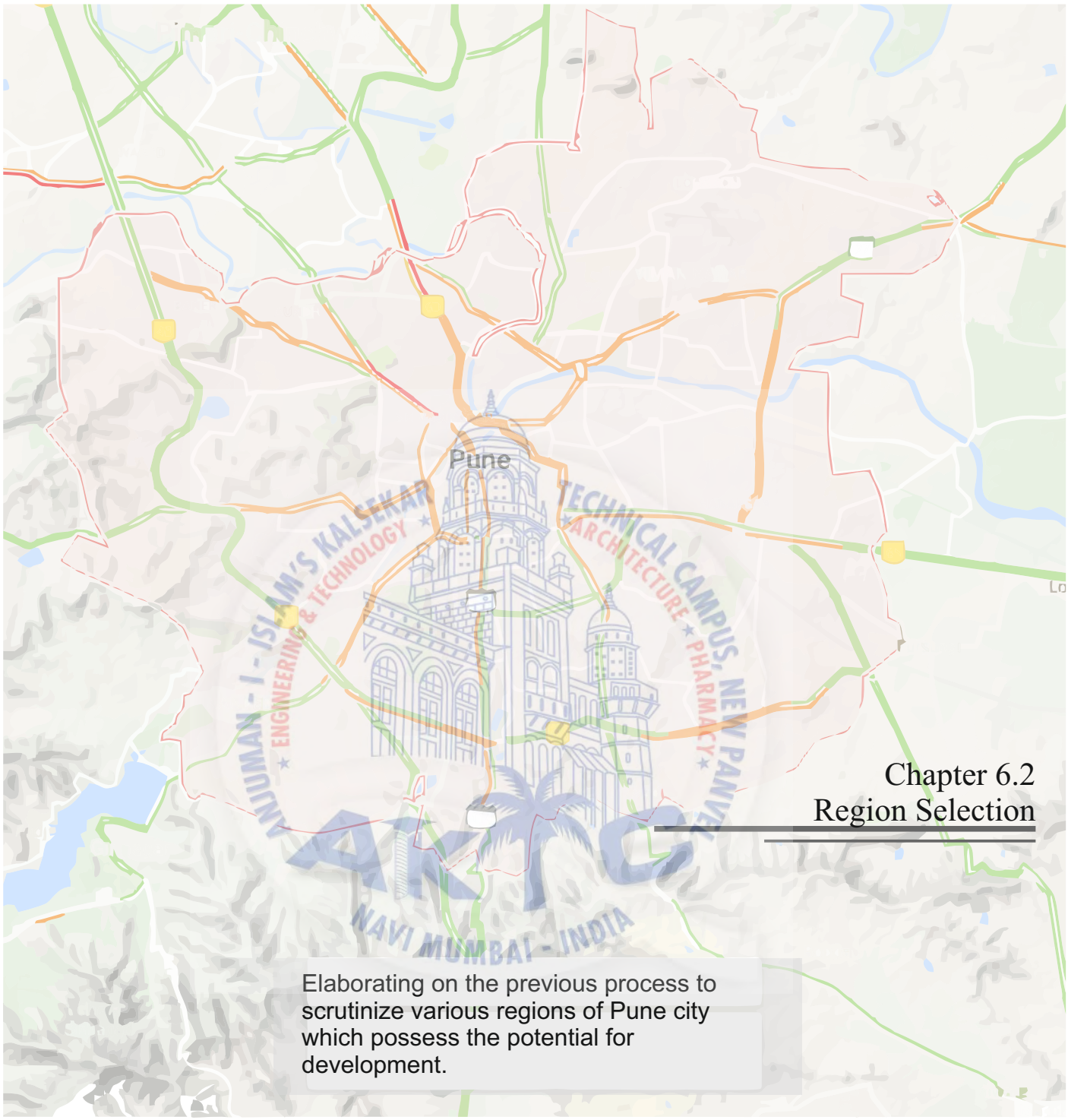
Inference: Max Wind Speed: 8m/s coming from west

N – S-W gives the maximum temperature ranging form 24 deg.C - 38 deg.C

5)Wind wheel







Chapter 6.2
Region Selection

Elaborating on the previous process to scrutinize various regions of Pune city which possess the potential for development.

Region selection to execute design thesis

The Institute focuses on providing lacking resources to the public sector. Its prime targets are focusing on people from various backgrounds.

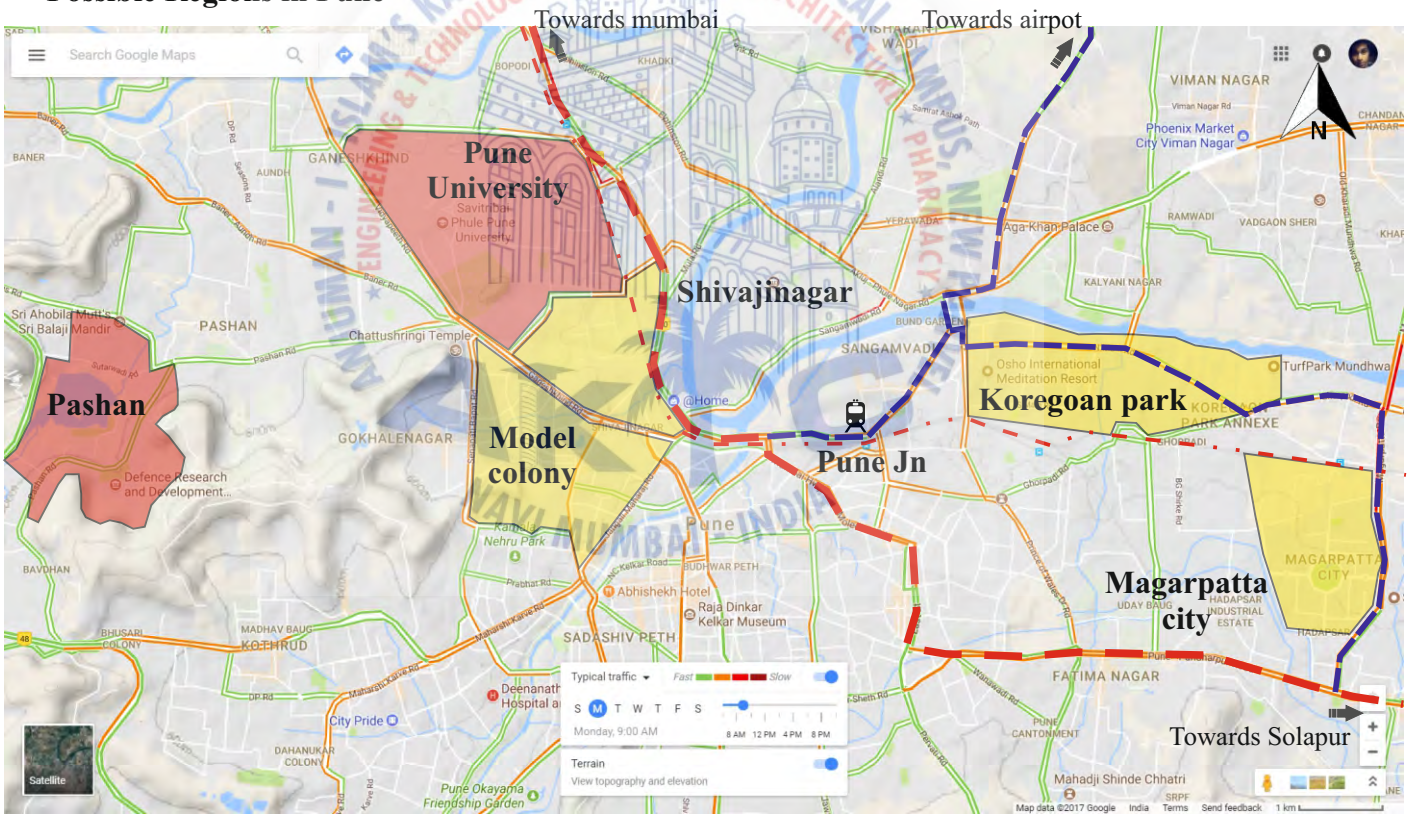
1. Architects,
2. Engineers,
3. Artists.

With the aim of promoting Digital Architecture in India, a part of the institute will also be open to public where they can come in, and see how imaginations are converted into reality.

Thesis proposal demands a region in which it can be

1. Easily accessible to the public.
2. Close proximity to Public transportation services.
3. Close proximity to Residential zones, so that it can be easily accessible by the students.
4. Close proximity major road, where it can be promoted easily.
5. Preferably near the heart of the city

Possible Regions in Pune



Possible regions (Distance from Pune Jn station)

1. Pune University - 5.5 km
2. Shivaji Nagar - 3.1 km
3. Pashan - 8.6 km
4. Model Colony - 4.4 km
5. Koregoan Park - 3.4 km
6. Magarpatta & Amanora City - 9.4 km

Legend

- Mumbai- Pune highway
- Main connecting roads
- Railway line
- Institutional zone
- Residential zone

Facts about the Regions

Comparing the Short-listed regions on the basis of

1. Easily accessible to the public.
2. Close proximity to Public transportation services.
3. Close proximity to Residential zones, so that it can be easily accessible by the students.
4. Close proximity major road, where it can be promoted easily.
5. Preferably near the heart of the city

1.Pune University

1. It is one of the renowned institute zones in Pune.
2. It has close proximity to nearby residential zone and is nearby to the heart of the city.
3. The proposed institute cannot act as an extension to an existing College.
4. Land availability is less.
5. Distance from Pune station: 5.5km
6. Distance from Pune Airport: 12.4 km

2. Shivajinagar

1. It is one of the well known and well connected region of pune.
2. It has close proximity to pune station: 4.6 km
3. It is a prime residential zone and has many old institutes in its region.
4. Distance from Pune Airpot: 11 km
5. Land availability for new development is less.

3. Pashan

1. It is known for its pashan lake.
2. It has many residential zones and some old govenment and private institutes in its region
3. It has relatively more land availability for new development.
4. Distance from Pune Station: 8.6 km
5. Distance From Pune Airpot:

4. Model Colony

1. One of the Renowned college Symbiosis Institute is in this region.
2. It has less land availability for new development.
3. Distance from Pune Station: 4.4 km
4. Distance From Pune Airpot:

5. Koregoan Park

1. Most Elite region of pune, with many renowned structures like Osho Meditation Centre and has many residential and commercial zones within the region
2. Distance from Pune Station: 3.4 km
3. Distance From Pune Airpot:

6. Magarpatta & Amanora City

1. Its is a new development as a model township developments where a person can get all services, eg. residential, entertainment & leisure, commercial all at one place
3. Distance from Pune Station: 9.4 km
4. Distance From Pune Airpot:

Chapter 6.3
Site Selection

Analyzing numerous Sites with respect to different factors like proximity, resources, context, etc.

Possible sites to execute design thesis

1. Site near Shivaji nagar
2. Site near Pashan lake
3. Site near Koregoan Park.
4. Site Near Amanora city.

Sites are compared on the basis of

1.Location Proximity **3.Area**

2.Contextual features **4.Landuse**

Site Near Shivajinagar

Proximity Data:

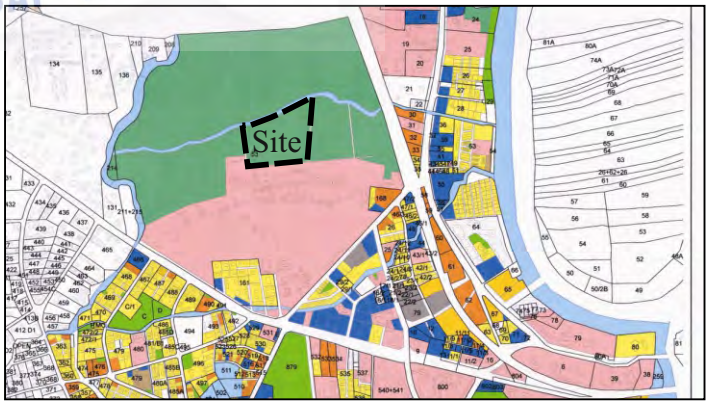
15 Min **27 Min** **53 Min** **30 Min**

Distance From Pune Jn: 4.3 km

Distance From Pune Airport: 11.4 km

Facts:

- It is in a prime location. Shivajinagar and model colony on each adjacent sides.
- Close proximity to the heat of the city.
- Site area required for execution thesis proposal is approx 10 acres, hence this site used for the proposal.
- Site comes under agricultural zone.



Landuse plan

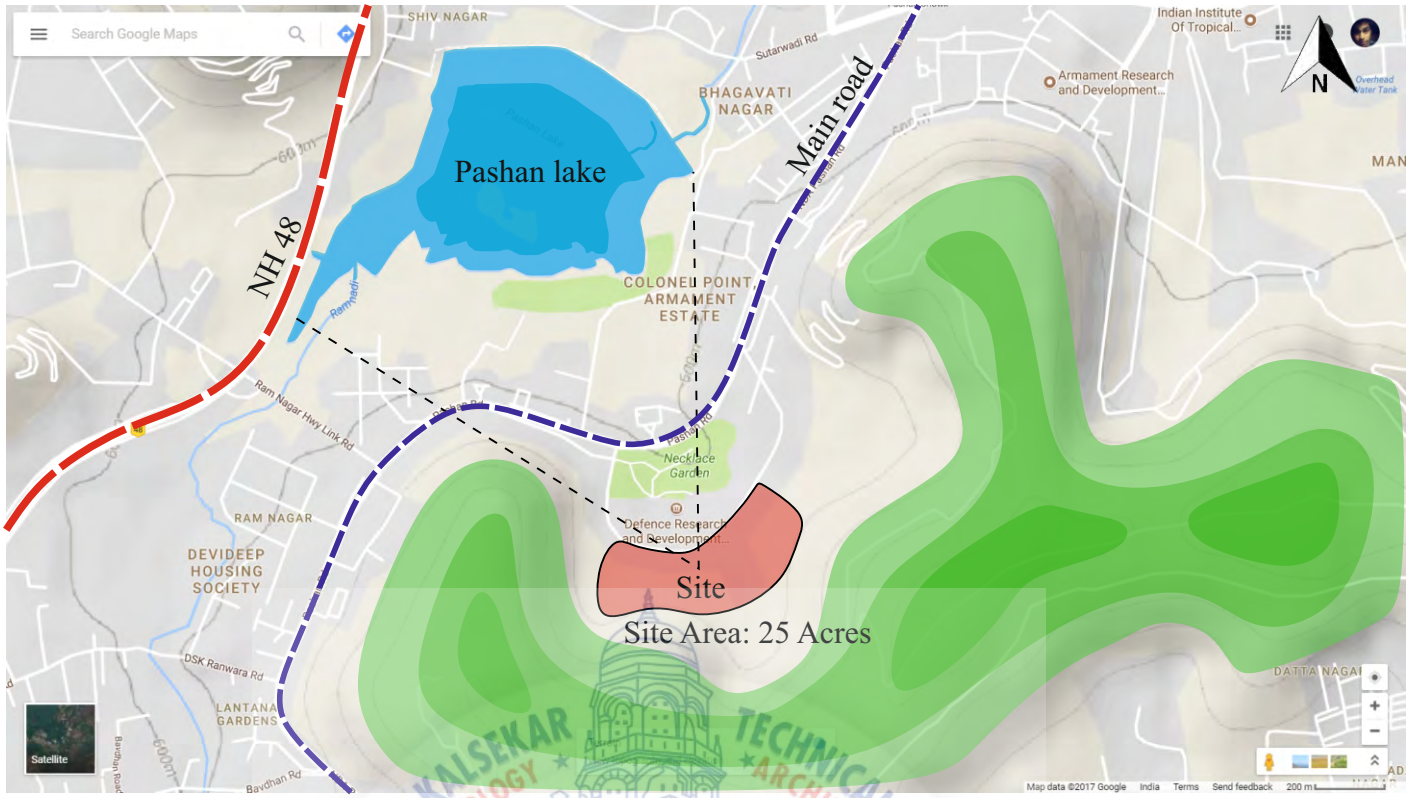
Fig.11; *Source: DP 2007-27 P.M.C*

Contextual features:

1. Close proximity to pune university, model colony and shivaji nagar.

Inference: Site has close proximity to prime location in Pune but it comes under Agricultural zone. Hence it cannot be used.

Site Near Pashan lake



Proximity Data:

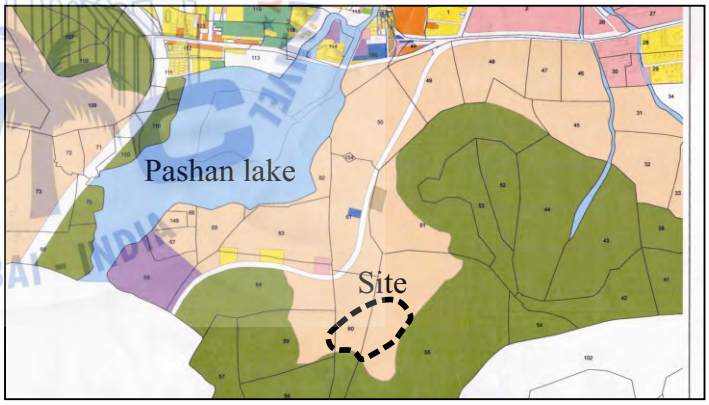
43 Min	**50 Min**	**137 Min**	**59 Min**

Distance From Pune Jn: 12 km

Distance From Pune Airport: 17.8 km

Facts:

- Site is located in isolated area.
- Site is surrounded by hill top and in Pune, and in Pune they are reserved for ecological reasons.
- Site comes under defence zone.
- No access from main road, because the road passes through defence institute.



Landuse plan

Fig. 12; *Source: DP 2007-27 P.M.C*

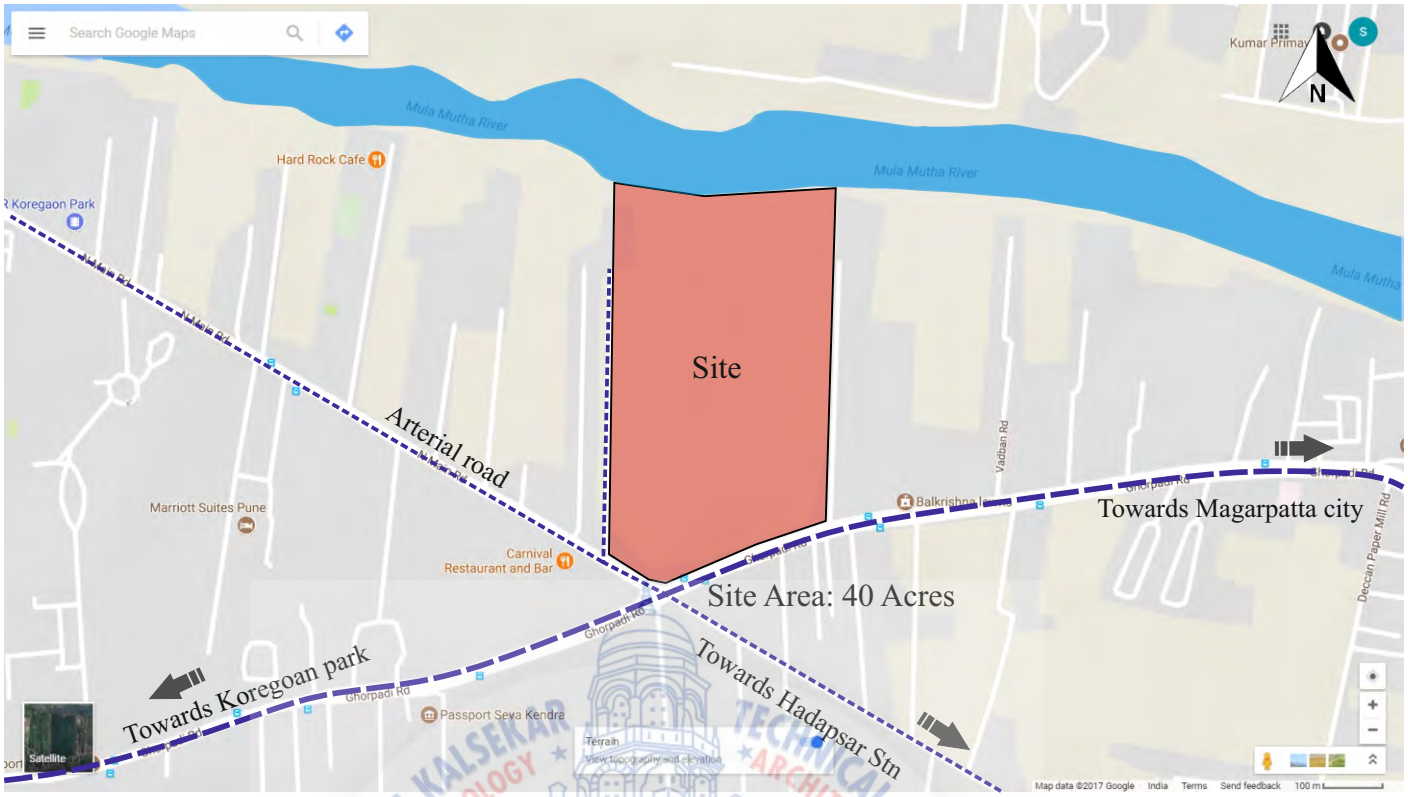
Contextual features:

1. Pashan lake is one of the prominent areas for bird watching.

2.Site surrounded by hill.

Inference: Site has good contextual features but it comes under defence zone. Hence it cannot be used.

Site Near Koregoan Park



Proximity Data:

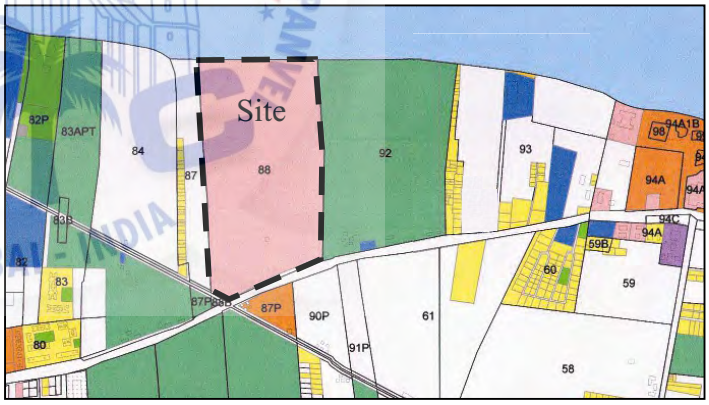
21 Min	30 Min	70 Min	17 Min

Distance From Pune Jn: 5.3 km

Distance From Pune Airport: 7.4 km

Facts:

- Site is located on a road junction
- Best proximity w.r.t the other short listed sites, located in one of the prime locations in Pune
- Many 5-star hotels in close proximity
- Existing use: Botanical survey of India, currently used for ecological purposes



Landuse plan

Fig.13; *Source: DP 2007-27 P.M.C*

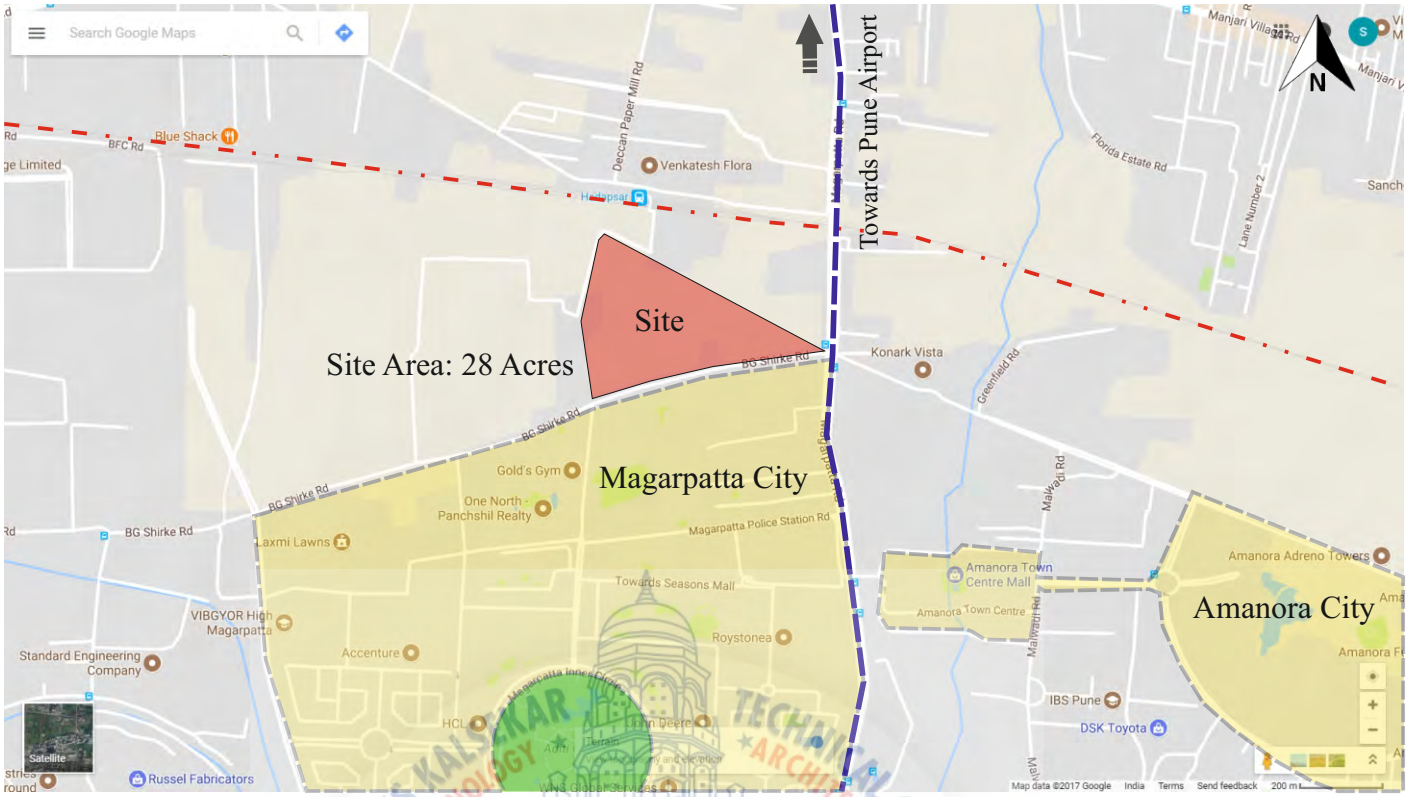
Contextual features:

1. Mulla muta river flowing from its backyard

2.Site covered with immense vegetation

Inference: Site is allocated for institutional zone and has close proximity to the city.
Contextual are best suited for the program,
but it is already being used for some other activity
Hence it cannot be used.

Site Near Magarpatta City



Proximity Data:

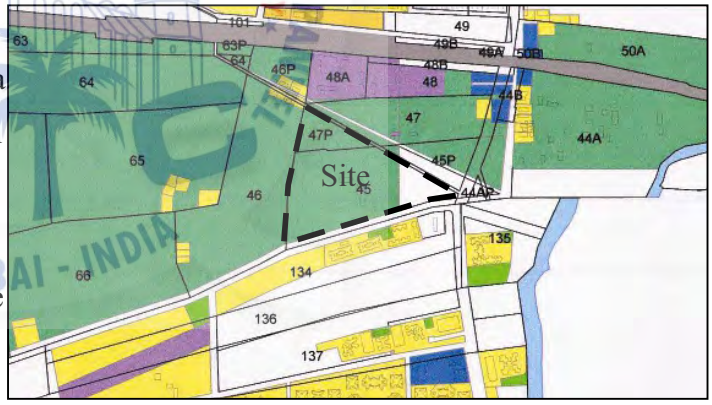
29 Min **43 Min** **90 Min** **34 Min**

Distance From Pune Jn: 9.3 km

Distance From Pune Airport: 11.5 km

Facts:

- Site is located near Magarpatta and Amanora city and Close proximity to Hadapsar station
- Its proximity is its advantages as it can get many users from its neighbourhood.
- Site boundary shape could be a disadvantage
- Currently the land is under dispute for converting it from agricultural to residential zone



Landuse plan

Fig. 14; *Source: DP 2007-27 P.M.C*

Contextual features:

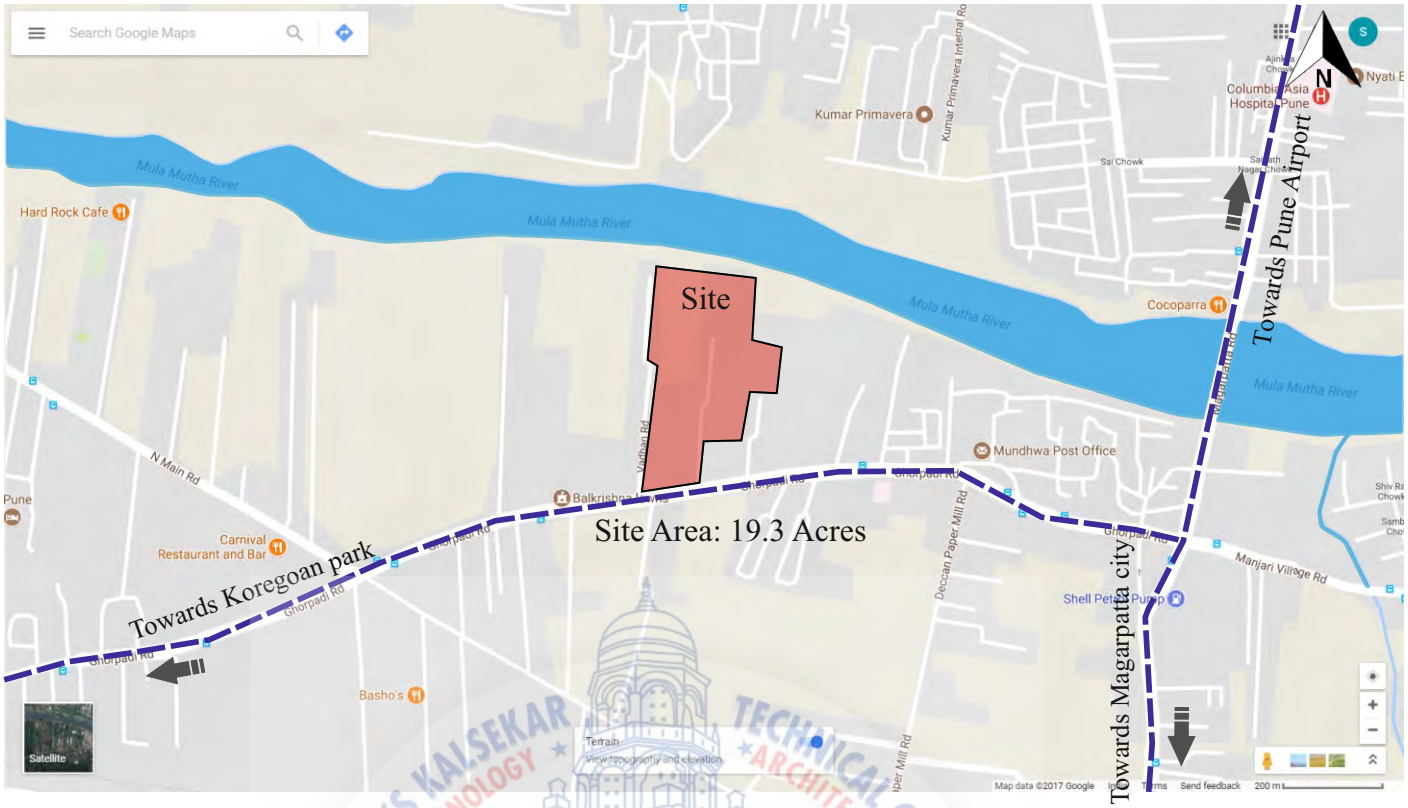
1. Close Proximity to Residential zone

2.Site covered with many low height vegetation

3. It gets views and vista from its adjacent flyover and surrounding high rise buildings

Inference: Site has more contextual feature advantages over other sites, but it is demarcated under agricultural zone.
Hence it cannot be used.

Site Near Vadhban



Proximity Data:

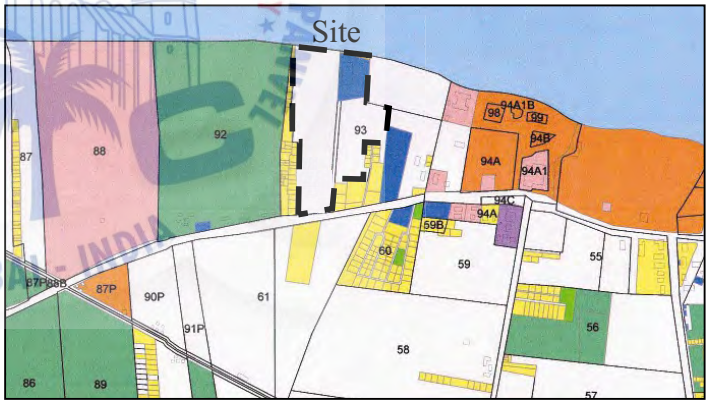
25 Min	33 Min	80 Min	24 Min

Distance From Pune Jn: 6 km

Distance From Pune Airport: 8 km

Facts:

- Best proximity w.r.t the other short listed sites, located in one of the prime locations in Pune
- Many 5-star hotels in close proximity
- Existing Use: old abandoned egg tray factory in site
- Close proximity to hadapsar station



Landuse plan

Fig. 15; *Source: DP 2007-27 P.M.C*

Contextual features:

1. Mulla muta river flowing from its backyard
2. Site has an old abandoned Factory
3. Close proximity to Magarpatta and Amanora city

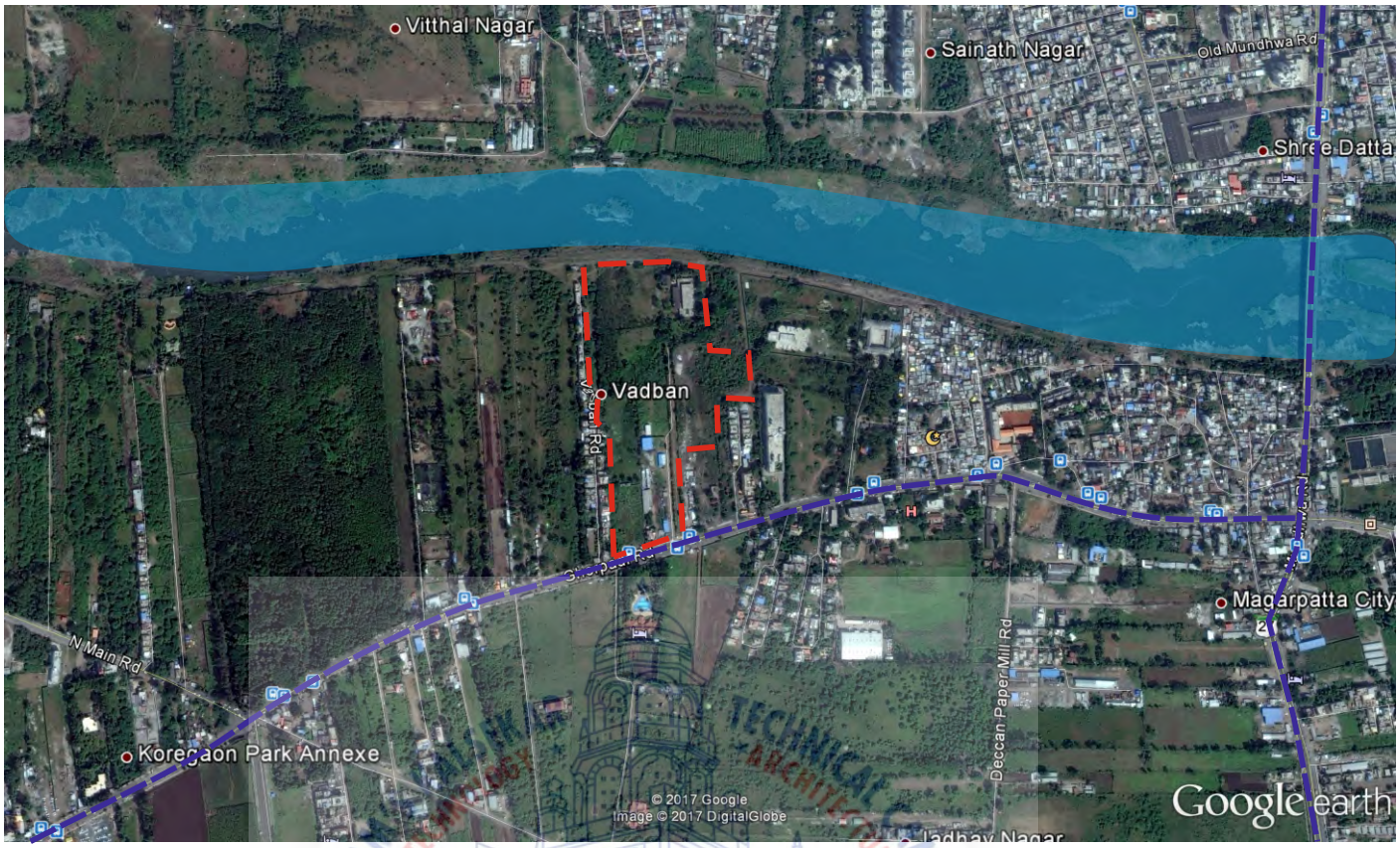
Inference: Site has more contextual feature advantages over other sites

Site is vacant and currently not under use and located near the heart of the city.

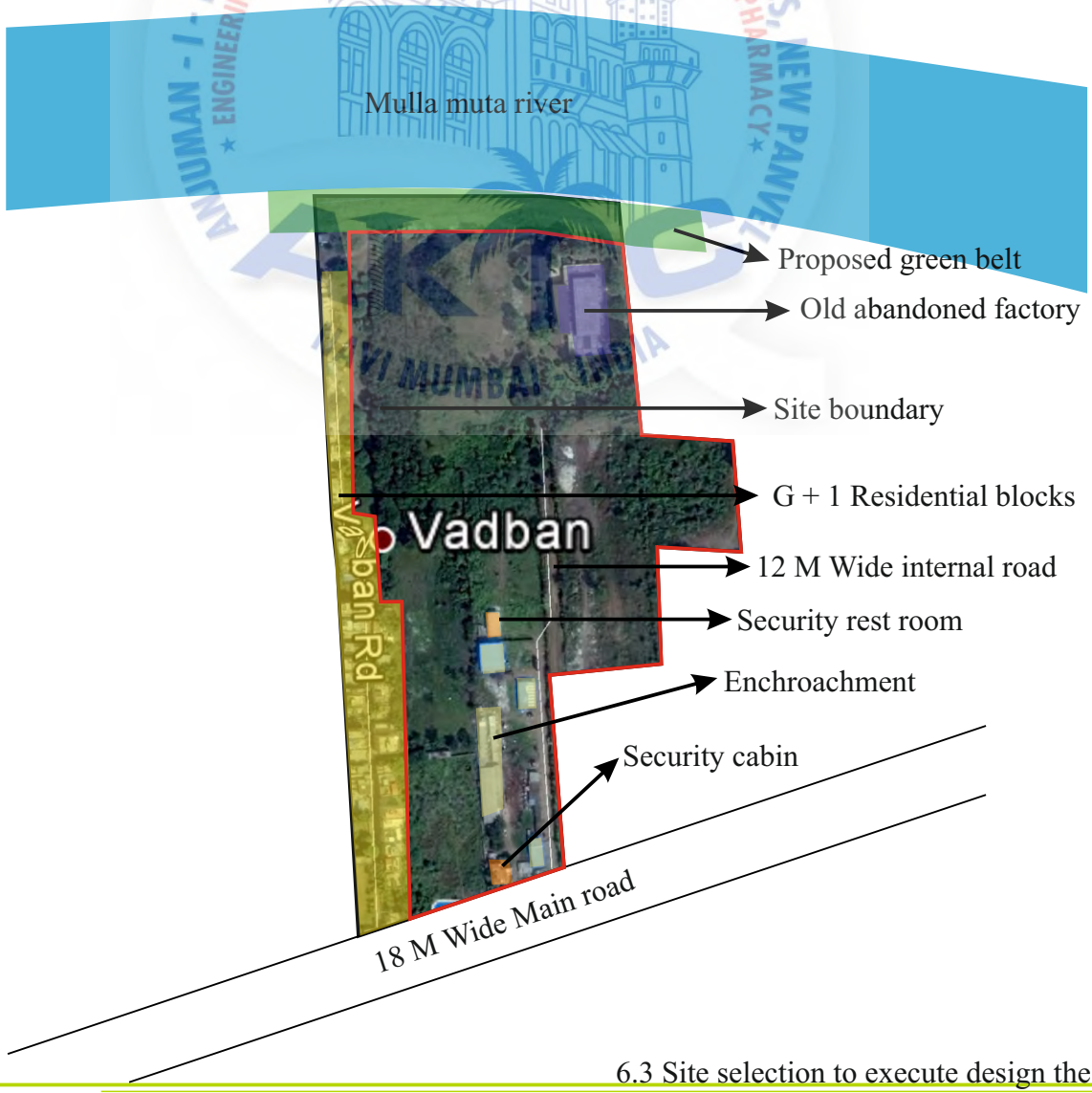
Main approach road is used by many users to reach their other destinations, hence best suited for executing thesis Proposal

This site can be used for executing thesis proposal

Google Earth image



Site observations



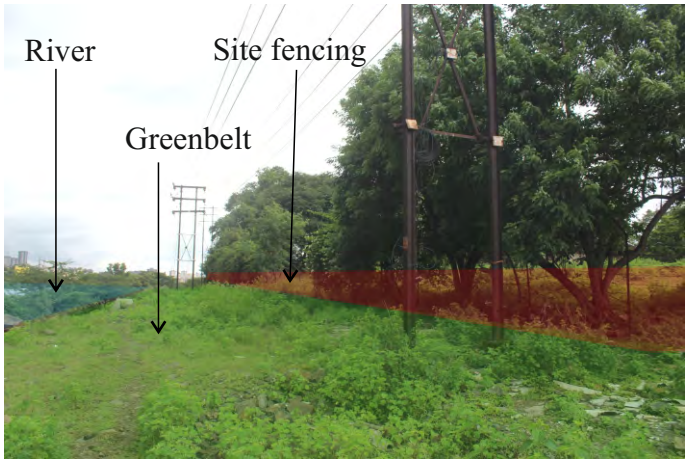
Site images

1. Site from river side, Green scapes in site

2. View of the abandoned factory

3. Unplanned vegetation on site

4. View from the front side



5. Electric overhead cables running adjacent to the site

6. Security restroom

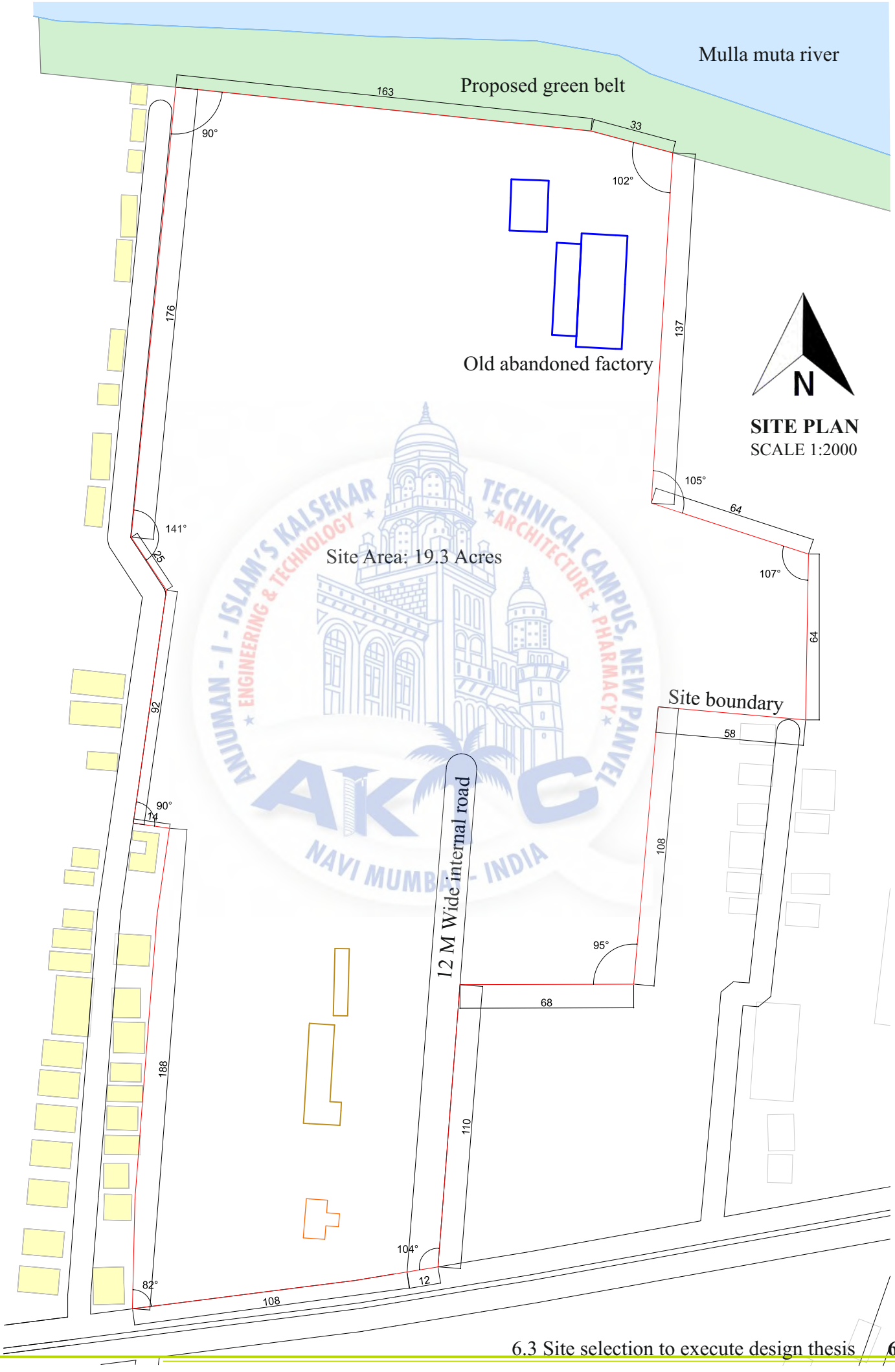
7. 12M wide main access road into the site

8. 18M wide road touching the site

9. Steps leading to the river (waterfront opposite to site)

10. View of the River flowing adjacent to the site

11. Panoramic View of the river and context


Mulla muta river
Proposed green belt
163
33
90°
102°
176
137
Old abandoned factory
N
SITE PLAN
SCALE 1:2000
105°
64
141°
25
107°
Site Area: 19.3 Acres
64
92
Site boundary
58
90°
14
12 M Wide internal road
108
95°
68
188
110
104°
82°
12
108

Chapter 7
Architectural Space Programme

A collective approach towards developing the design program based on the research and analysis conducted through multiple media.

The institute focuses on adding plugins to the core subject to expand the possibilities and widening its scope for the research. The following topics which can help in research and development of the institute are.

Advanced interation | Intelligent cities | Robotic interface and interactive architecture design tools | Space and material simulation | Bionic architecture | Parametric Urbanism & Urban mapping | Fractal architecture | Digital Tools and Organic Forms | Self sufficient habitats | BIM | Intelligent construction | Biomorphism | Digital fabrication | Living systems | Material science in digital architecture | Computer aided design | Self sufficient buildings | 3-D printed buildings | Creation of art in V-R | Augmented Reality | Virtual Reality

Major Subjects:

1. Bio-digital Architecture
2. Self-Sustainable structures
3. CAD and Technologies
4. Research and Development in Construction

→ **Advanced Architecture**

5. Fabrication and Digital tools
6. Advanced Interaction
7. Mapping

→ **Advanced Interaction**

It covers applications of Digital architecture at various levels

1. Product level
2. Architectural level
3. Material level
4. Urban level

Types of Courses :	**Intake of Students**
Certificate Course (C1) - 3 months	30
Certificate Course (C2) - 6 months	20
Ma01- 1 year (Advanced Architecture)	25
Ma02- 1 year (Advanced Interaction)	25
Ma03- 1.5 years (Advanced Architecture)	25
Ma04- 2 years (Advanced Architecture)	50
Ph01- 3 years (Bio-digital Architecture)	10
Ph02- 3 years (Self-sustainable structures)	10
Ph03- 3 years (Advanced interaction)	10

Institute for research and development in digital architecture							
			Preliminary area schedule				
sr no.	Assigned area	No. of room	Capacity	Min area per student	Area	Notes	Total area (sq.m)
	Built Area						
A	**Primary Program (Private)**						
1	**Research lab**						
1.1	C1 lab	1	30	1.2	36		36
	C2 lab	1	20	1.2	24		24
	MA01	1	25	1.5	37.5		37.5
	MA02	1	25	1.5	37.5		37.5
	MA03	1	25	1.5	37.5		37.5
	MA04	1	50	2	100		100
	Ph01	1	10	1.5	15		15
	Ph02	1	10	1.5	15		15
	Ph03	1	10	1.5	15		15
	Research cell- For allied fields (Regular, Studio, Private)	1	20	3	60		60
2	**Fabrication lab**						
2.1	C1,C2	1	50	18	900		900
	MA	1	125	30	3750		3750
	Phd	1	30	30	900		900
3	**Simulation Room (Space)**						
3.1	MA	1	50	5	250		250
	Phd	1	10	5	50		50
4	**Simulation Room (Material)**						
4.1	MA	1	50	4	200		200
	Phd	1	10	4	40		40
5	**Computer lab**						
	C1- Rhino lab	1	15	1.2	18		18
	C1- Maya lab	1	15	1.2	18		18
	C1- Programing lab	1	15	1.2	18		18
	C1- BIM lab	1	30	1.2	36		36
	C2	1	20	1.2	24		24
6	**V-R Room**						
	Common	2	25	3	75		150
7	**Digital Library**						
	Common	1	245	1	245		245

8	**Faculty room**	1					
	C1		3	1.5	4.5		4.5
	C2		4	1.5	6		6
	MA01		6	1.5	9		9
	MA02		4	1.5	6		6
	MA03		2	1.5	3		3
	MA04		6	1.5	9		9
	Ph01		1	1.5	1.5		1.5
	Ph02		1	1.5	1.5		1.5
	Ph03		1	1.5	1.5		1.5
	Visting staff		10	1.5	15		15
9	**HOD Cabin**						
	C	1	5	3.6	3.6		3.6
	MA04	1	5	3.6	3.6		3.6
	MA01	1	5	3.6	3.6		3.6
	Phd	1	5	3.6	3.6		3.6
	Director	1	5	5	5		5
	Co-Director	1	5	5	5		5
10	**Seminar Hall**						
	Large	1	225	2	450		450
	Small	2	100	2	200		400
B	**Administrative Area**						
1	**Site Manager**	1	3	3.6	3.6		3.6
2	**Accountant**	1	3	9	27		27
3	**Surveillance**						
	Hod	1	1	12	12		12
	Staff	1	5	20	20		20
	BMS	1	1	15	15		15
C	**Axillary spaces**						
1	**Café for Institute**	1	150	0.7	105		105
2	**Hostel**						
	Dormitory	1	150	10.9	1635		1635
	Canteen	1	100	0.7	70		70
	Security cabin	1	2	5	10		10
	Hostel Manager	1	1	3.5	3.5		3.5

D	**Secondary Program (Public)**						
1	Fabrication lab	1	75	18	1350		1350
2	Simulation Room (Cinema)	1	50	2	100		100
3	Food Court	1	200	0.7	140		140
4	Open Auditorium	1	200	0.5	100		100
	Total Students		225				
	Total Faculty		68				
	Total staff		7				
	Total Footfall		300				
	Total Built-up Area						11499
						Add 15% Circulation a	1724.85
	Final Built-up Area						**13223.9**
	Open/Non Built Area						
E	**Exhibition area**						
	Execution /exhibition area/Workshop area		493	APD			
	Open area			APD	2000		2000
	Semi Closed			APD	3000		3000
	Parking						
	Total Area (Built+ Open)						**18223.9**
	Total Area Required for Site (sq.m)						**39671.6**
	Total Area Required for Site (acres)						**9.80307**

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List of Figures