

Strategies for Sustainable Design
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Lecture 39
Case 1: Campus Planning and Design of IIT Gandhinagar

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**Case 1: Campus Planning and
Design of IIT Gandhinagar**

Lecture 56

A Role Model



Week 12: SD Case Studies and Summary



Dr. Shiva Ji
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Hello everyone, in this lecture we will discuss about campus planning and design of IIT Gandhinagar. Well, to my understanding as far as, like I have studied and done this case study is one of the role model campuses, which has come up in the like recent times in recent years.

And it is definitely, I think because of the continuous and persistent efforts by the director of IIT Gandhinagar, Professor Sudhir K. Jain and his efficient and persistent team, which has been on this task for last, not less like a 10, 12 years now, and they have designed, they have like a, given their liberty and interest in the creating a sustainable campus, a sustainable project, and they have tried to address the three aspects of sustainability, environmental, social and economical in various ways possible.

So, at least by going through this case study, you will see the intent and what kind of intent they have formulated and accordingly like how they have formulated the design, how they have conceptualized the entire design of the IIT Gandhinagar. And lately, like how they have executed it, the campus is still under construction, but it is like a 1st stage of development it has received... the five-star ratings, which is one of the highest ratings presently in India. But overall impact if you see of IIT Gandhinagar on the three ESC aspects, it reflects in its true sense. So, that is why I believe, like, this is one of the role model design and execution

projects in the recent times. And, so, we must learn from this. So, let us go on this journey and explore more on this.

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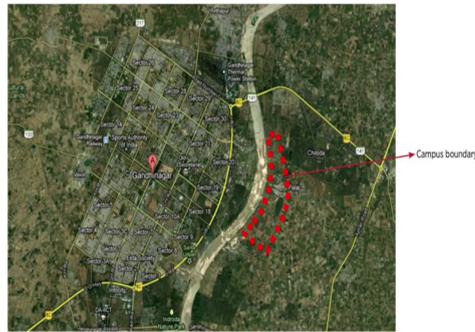


Image of the site before construction, from Google Maps



Week 1: Definitions and Perspectives on Sustainability in Industrial Design and Built Environments
Lecture 4: Technological interventions into building design
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So, well, in the, this is satellite map of IIT Gandhinagar and the city of Gandhinagar you can see over here, So, at the scale of, like at the city, you can see how big this campus is, and it is like a critical location. So, it is right across the, this river of Sabarmati here, on the other side. So, this was obviously before the constructions you see like as a green field project, So, it was like it carries even like a great responsibility, even like a more responsibility to perform on the sustainability aspects.

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Summary of project data and details

General Project Data	Project Details
<p>Project type : Institutional Campus</p> <p>Location : Palaj, Gandhinagar</p> <p>Country : India</p> <p>Site area : 400 acre, approx.</p> <p>Developable land : 250 acre, approx.</p>	<p>Main procedural stages of Campus Planning:</p> <ul style="list-style-type: none"> • Masterplan • Phase IA : Academic buildings Hostels for 1200 Students Staff Quarters • Phase I : Hostels for 1200 Students Guest House and Support Facilities Director's Residence Sports Facilities and Arcade • Phase II : Hostels for 2400 Students Additional academic and other build up • Phase III : Hostels for 1200 Students Additional academic and other build up
<p>Project Summary</p> <p>The Masterplan designed to address the total strength of 6000 students and supporting faculty and staff has been divided into 3 Phases.</p> <p>The Architectural and Infrastructure design of Phase IA and Phase I for 2400 students and supporting faculty and staff were developed keeping in perspective the long term objectives of IITGH as well as catering to present and immediate future.</p>	<p>https://campus.iitgh.ac.in</p>



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So, let us see, the brief introduction and the summary of this project data of this project, well it is an institutional campus, location *Palaj* village awfully near the city of Gandhinagar, in the district of Gandhinagar in the Gujarat, India. Site area approx. like 400 acres, developable land what they have taken is around 250 acres, rest of the 150 acre is still left for like a future expansion and the green, as a like a green area.

Project details, well phase IA academic buildings hostels for like 1200 students, staff quarters, and phase I has a hostel for like 1200 students, guesthouse, support facilities, director's residence, sports facilities and arcade, phase II has a hotel for 2400 students, additional academic and other build up area, phase III has finally like hostel for like a 1200 more students, additional academic and other build up area.

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Project Summary

- The Masterplan designed to address the total strength of 6000 students and supporting faculty and staff has been divided into 3 Phases.
- The Architectural and Infrastructure design of Phase IA and Phase I for 2400 students and supporting faculty and staff were developed keeping in perspective the long term objectives of IITGN as well as catering to present and immediate future.
- Ar Vinod Gupta: Space-Consultants, New Delhi
Ar Ujan Ghosh: Upal Ghosh Associates, New Delhi
Ar Mohammad Shaheer: msyk DESIGNS, New Delhi



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So, the project summary, the master plan designed to address the total strength of approx. 6000 students and supporting faculty and staff has been divided into three phases what we saw, the architectural and infrastructure design of phase IA and phase I for like 2400 students and supporting faculty and staff were developed, keeping in perspective, the long-term objectives of IIT Gandhinagar as well as catering to the present and immediate future.

Well, the architects are the main, chief architects involved from like, three different architecture like consultancies. So, you can see the names over here Architect Vinod Gupta from Space-Consultants, New Delhi, Architect Ujan Ghosh from Upal Ghosh Associates, New Delhi and Architect Mohammad Shaheer from msyk DESIGNS, New Delhi. Well, there

are other agencies and institutions also involved in the design and execution of this project. Well, the names are not given over here.

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CAMPUS HIGHLIGHTS



Student Housing

- 6 hostel blocks accommodating both UG and PG students
- Each block having a capacity of about 200 students
- A common hostel library and reading area
- Spacious single and double seated rooms
- Specially designed to be accessible to persons with disabilities
- Energy efficient
- Modern style designs drawing inspiration from traditional Ahmedabad architecture

Dining

- Central dining facility for all students
- Two independent mess facilities
- Modern and well equipped kitchens
- A variety of food and beverage joints spread across the campus
- A large central cafeteria with open air seating





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So, some of the campus highlights, this data I have source from the like IIT Gandhinagar website, and they are generous enough, I really praise the effort by the director, and our Professor Sudhir Kumar Jain who has inspired his team to create, and a document these entire processes of this design and implementation. And they have made those documents available on the IIT Gandhinagar website for referencing, So, I am really thankful to them for this effort. I usually, these like a such kind of our designs go unnoticed because the resource material the research material is not made available to the public.

So, I am sure I think is one of the novel approaches on this front also, because the future architects, designers and like other, like researchers, and students such as you can benefit from such resources So, you can visit IIT Gandhinagar website, you can find such these research materials, these documents over there.

So, for the student housing, I am just quickly reading these, six hostel blocks accommodating both UG and PG students, even like a each block having a capacity of about like a 1200 students, sorry 200 students, a common hostel library and reading area, a spacious single and double seated rooms especially designed to be accessible to persons with disabilities and are energy efficient, modern style designs drawing inspiration from traditional Ahmedabad architecture, that we will also discuss in the coming slides.

So, how this dry and arid region of like a Gujarat and it is like a vernacular architectural style has played role in evolving the concept of these housing areas, is also like a interesting to witness, for the dining, central dining facility for all the students to independent mess facilities, modern and well equipped kitchen, a variety of food and beverage joints spread across the campus, a large central cafeteria with open air seating.

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Sports

- Football field
- Cricket field
- Volleyball courts
- Basketball courts
- Jogging track
- Hockey field
- Gymnasium
- Table tennis rooms

Recreation Spaces

- Terrace gardens
- Riverside promenade
- Rooftop open air theatres
- Jal mandaps
- Central vista
- Two natural lakes





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For the sports, football, cricket volleyball, basketball, jogging track, hockey, gymnasium and other like a table tennis rooms etcetera. for like a indoor outdoor or like a gaming and sports facilities, recreation spaces such as like a terrace garden, riverside promenade rooftop over open air theaters, *Jalmandapas*, central vista, two natural lakes are also kept in the inside the IIT Gandhinagar campus.

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CAMPUS IN NUMBERS

 <p>400 ACRES is the total land area on the banks of the river Sabarmati</p>	 <p>6 Architectural Firms from different parts of the country collaborated for the venture</p>	 <p>100 Feet tall landmark tower is one of the most distinctive architectural features</p>
 <p>1200 Students accommodated till date and 6000 Students will be accommodated by the end of the project</p>	 <p>3.5 Kilometer of riverfront adorning the campus</p>	 <p>75 Trees transplanted using advanced hydraulic machines</p>

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So, as you like a highlight, we can see these numbers like 400 acres is the total land area on the banks of the river Sabarmati. 6 architectural forms, from different parts of the country, collaborated on this venture. 100 feet tall landmark tower is one of the most of the distinctive architectural features, present on the campus. 1200 students accommodated till date and 6000 students will be accommodated by the end of the project.

So, that is about the 1200 students at phase one and phase one a. Further like 3.5 kilometer of Riverfront adorning the campus. So, one of the long stretches along this river, a beautiful river, and they have sinned, they have located 75 trees, so 75 trees transplanted using advanced hydraulic machines, so that they need not to cut them down for the lack of construction stays. So, it is a novel approach to relocate these grown-up trees, from one place to another.

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GREEN CAMPUS
A plethora of green initiatives are being undertaken in the campus

INTERACTIVE CAMPUS
The campus has been designed to foster interdisciplinary and interbatch interactions

FREE AND OPEN CAMPUS
The institute philosophy allows all kinds of new initiatives and experiments

SMART CAMPUS
A wide range of innovative technologies have been implemented to make an intelligent campus



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Further, it is a green campus, a plethora of green initiatives are being undertaken in the campus. Interactive campus, the campus has been designed to foster interdisciplinary and inter batch interactions. Free and open campus, institute philosophy allows all kinds of new initiatives and experiments. Smart campus, a wide range of innovative technologies have been implemented to make intelligent campus.

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COMMENDATION AWARD
IA AWARDS 2015 - URBAN DESIGN AND MASTER PLANNING

Master Plan for IIT, Gandhinagar



Ar. Vinod Gupta - E mail: vinod@space-design.com
Ar. Vinod Gupta, Alumnus of School of Planning and Architecture, New Delhi and Indian Institute of Technology, Delhi, Vinod Gupta has been a teacher in architecture and industrial design at SPA, Delhi. He is partner in Space Design Consultants and Director of Open Indigo Designs Pvt. Ltd. Vinod Gupta's contribution has been in environment friendly architecture and interior design. His current work focuses on sustainable design and ergonomics and includes master planning, architecture and furniture design.



Ar. Ujan Ghosh - E mail: ujanghosh@googlemail.com
Ar. Ujan Ghosh did his Bachelors course from the School of Planning and Architecture, New Delhi in 1975 and Master of Architecture and Master of City Planning in Urban Design from University of Pennsylvania, Philadelphia in 1980. He is a senior partner at Ujan Ghosh Associates since 1982 providing consultancy services in architecture, interior and urban design. He is also a visiting professor of SPA, New Delhi and a founder member of Institute of Urban Designers, India.



This master plan is the document that would guide the development of IITGN campus for years to come. It defines the open space structure, movement system and the infrastructural services required for great buildings to come up. The Urban Design scheme gives the architect of individual buildings and structures the greatest freedom.

The Project :
IIT Gandhinagar campus on 400 acres of land on the western banks of river Subarnaree for 10,000 students
Status : Project completed - Buildings built - students have moved in

- Our Goals :**
- Efficient use of land
 - Efficient use of built space
 - Zero water import
 - Zero energy import
 - Zero waste export
 - Mobility without cars
 - Preservation of bio-diversity
 - Social Equity
 - Calculation of food-omnise
 - Harvesting energy omnise
 - GRHA rated campus



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Well, this is a like an introductory page you can see over here about the like a master plan, how they have evolved this master plan. So, you can see the two key architects associated with this project, since its is the inception architect Vinod Gupta, I have personally like a have some correspondence from here also on the regard of this, like regarding the research on

the IIT Gandhinagar campus, like design and rehydrating. So, he was gentle enough to reply and satisfy my equations.

Further you can see the goals what they have established over time for this project is to efficient use of land, efficient use of build space, zero water import, zero waste export, mobility without cars, preservation of biodiversity, social equity, cultivation of food on site, harvesting energy on site, GRIHA rated campus. So, you see some of these are very common either like other projects also, but some of these our goals are not so common at other projects such as you can see like zero water import.

So, in principle, it is like taken over here that the water requirement will be met from the like a site itself and that is why they have created a very strong network of water harvesting and water connecting and water filtration and treatment like a facility on the campus. They are located in different parts of the campus and a zero waste exports. So, that means like a no waste will be thrown out of the campus will be sent out of the campus.

So, they have their own on campus disposal systems also in place for example, like a green waste, like a kitchen waste, vegetables and other like such like organic waste. So, they have are recycler on the campus itself. Further like it promotes preservation of biodiversity because, as we saw in the like our master plan, this site is a like a Greenfield site and it has traditionally been like either like agricultural or like a ravenous the barren area, which had n number of like trees and other like a flora and fauna inhabiting on this place for a very long time. And cultivation on food on site.

So, this also is one of the novel initiatives this campus has taken, and they have promoted this agricultural of farming on the campus by the faculty staff and their family members even like students. So, that the new generation can at least learn how this agricultural world how and where we source our food from. So, this is one of the normal initiatives because the children these days who are coming from the like urbanized areas, they have for like a certain number of years, they do not have this exposure of idea, where are we sourcing like our food.

Whenever we ask them, where are we getting our food from? They mentioned about the answer the supermarkets. Well, that is not correct. So, this is one of the interesting initiatives taken personally from the director and he has promoted, and again like harvesting energy on site. So, they have some solutions like a photovoltaic cell and like other things to generate energy on the campus itself.

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Client's brief :

- An ambience that sets the campus apart from others
- Provides functional convenience and promotes interaction among students and faculty
- Uses resources efficiently and leads to GRIHA rating for buildings and the whole development.

Built Space Requirements :

The initial set of space requirements assessed by GCDC and the active participation of the committee of stakeholders is:

Phases	1	1a	2	
Total Number of Students	1200	2400	4800	
	Areas (in sqm)			Total area
A Administrative area	0	6293	0	6293
B Academic area	25230	19129	44359	88718
C Lecture Halls & Teaching Labs	8508	7845	16353	32706
D Central Facilities	0	12775	11720	24495
E Sports Facilities	0	7300	0	7300
F Services	6100	0	4475	10575
G Staff Residences	50600	38940	86075	175615
H Guest House Complex	0	4050	4050	8100
I Married Student Housing	0	7980	7980	15960
J Student Hostels	42900	51600	56700	151200
Total for Built space for phase	133338	155911	231712	520961
Grand Total for Built space				520961

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Some brief about the like a built-up area, you can see over here, we do not have the any need to repeat these numbers, but you see the number of total numbers in the different phases from 1200 to 22,400 up to like a total of 4800. Finally, like up to like the project will house 6000 students in the future.

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Land Use

On a 450-acre site that lies between the river Sabarnati and a highway, the first phase of the project is designed for 2400 students, second for 4800 students with expansion to 6000 students. 40% of the land is eroded and ravensous, parts of it being below the Highest Flood Level of the river. The southern pocket has a large contiguous area suitable for the main campus. The northern pocket will be used only in parts leaving a substantial portion as a habitat for 'neel gal' and other existing fauna.

Climate

Gandhi Nagar is hot and dry for 6 months and hot humid for 3 months while 3 months are relatively comfortable. Cooling is required for most of the year. During the dry summer months humidification is also required.

During the monsoon months June to September, especially in July and August, rainfall is heavy and rain protection is required for pedestrian walkways. In the final analysis, the climate is hot and without cooling systems the buildings cannot be made comfortable only through passive structural arrangements.

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So, land if you see this is the master plan, you can see over here, this campus has this Palaj village, impregnating in the middle of this stretch. So, they have made some arrangements to keep the interaction with this village people existing and continuing for like a longer period of time. So, there are some considerable efforts, given in this direction also to not to create a

very hard and tall a boundary wall and bifurcating is like a boundary wall from here from this village to this campus.

So, they have a softer half height wall over here through which is still there will be a sense of connectivity or virtual connectivity from this side to the other side. So, if you see like this climate on the climate terms, this place falls in like a hot and dry region and it remains so for like a longer period of time up to like 6 months and hot and humid for like 3 months and 3 months are relatively comfortable in the like winter months.

So, cooling is required for like most of the year during the dry summer months humidification is also required. So, as you may be aware of Gujarat and Rajasthan greens are one of the hottest and arid regions. So, the humidity also goes very little in these months. So, this humidification is also needed in some of these months. And of course, cooling the temperature is also required, because these are one of the very hot regions of India.

In the July and August, well there is a rainfall plenty like the rainfall and atmosphere becomes like a pleasant. Climate is hot without cooling systems. The buildings cannot be made comfortable only through passive structural arrangements. So, as we can see, it is the climates requirement is the geographical compulsion that this project could not survive completely on the like passive cooling methods and that is why they have gone to adopt like a controlled other like a mechanical way of controlling the temperature and the humidity on the campus.

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NPTEL

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So, this slide gives you this geographical location like how is it divided into like two parts there is a road which passes from like, the middle from here, and this is the location of this Palaj Village. But almost if you see the 40 percent of this land is ravines and this thing. So, it is very interesting, this land formation and it is habited to several like a species of reptiles, insects, and animals, traditionally since it is located next to this river.

So, this has been so far a very long time and approach in the like a design of this campus is like to cause the minimal disturbance to these habitats and they have tried to maintain these ravines as it is, this is one of the novel approaches adopted in this project. So, you can see the location of this village, location of this river, the ravines and like the highway and the road network in this plan.

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Further like as an inspiration they have not used this modern these cities planning and these grid layouts. Rather they have used this compact belt form model after the like old Ahmedabad city. So, if you visit the old Ahmedabad city, this is a traditional vernacular architectural planning system to plan like neighbors in a like a tightly knit spaces with the lack of a taller houses and narrower lanes. In order to reduce the sunlight, the direct sunlight in the like open spaces and common areas.

So, that is principle used in the design of the habitation areas and the community areas, residential areas on the campus. Some more details you can see like energy efficient buildings like are designed up to three floors. So, that they are easily walkable, no need of like

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So, further if you see this, they have taking help of this shaded academic spine they call. So, it is a common shaded long stretch where their space frames use on the top in order to minimize falling off direct sunlight in this area. So, this area is designed for like walking and cycling here at the level. So, it connects with different departments and research labs from the like ground level. So, that people can easily take a walk. Hostel central court, so these details over you can see over here how water bodies, how the greenery have been utilized to create ambient temperature inside these promises.

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Sustainable Design

The campus has been designed to be largely free of cars and other motorised transport. Pedestrians and cyclists have special scenic routes separate from vehicular roads, through the campus. While

vehicular access has been provided to all housing blocks, parking at the academic blocks has been restricted mainly to cycles. For internal mobility, the campus provides environment friendly electrical vehicles for universal access and as a means of public transport. The plan ensures zero discharge of waste water. Onsite harvesting of rainwater and solar energy. Waste water is used for growing food and fodder plants.

The campus of IITGN has been awarded a five star GRIHA LD rating. It is the first campus in the country to get GRIHA LD rating and will define norms for such developments.



Project Details	
Project Category	: Urban Design & Master Planning
Project Name	: IIT Gandhinagar
Completion Date	: July 15, 2015
Location	: Gandhinagar, Gujarat
Plot size	: 400 acres
Area	: 5600000 Sq. Ft.



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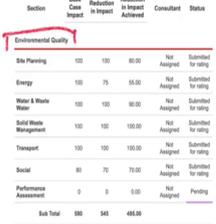
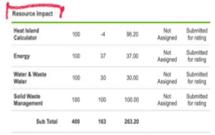
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Further like a pedestrian friendly like a campus. Well, it is a GRIHA 5 star rated projects. So, you can see over here, this is the plate they received. So, one of the a very efficient designs which has come up in the recent times.

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Well, here we will see the report how much of like the scoring this project has received. So, this is GRIHA LD documentation, and I have received from like GRIHA website. Here the slab of like this a star rating if you see impact on the site, so the impact is if it is in the range of like 66 to 75 percent that project receives like 1 star, if the impact is in the range of 56 to 65 percent receive 2 star, similarly 46 to 55, 36 to 45 and less than 35. So, this project I receive you can see over here is the overall project impact of this project is 25.89.

So, which is comfortably falling under this threshold of 35 and this is why the rating given to this project is like 5 star. The further bifurcations you can see over here. So, on the resource impact how much it has feared. So, there are four parameters on the left you can read like a heat island calculator, energy, waste, water and wastewater, Solid Waste Management. So, overall, it has like these many scores.

On the environmental quality if you see like there are like a site planning energy, water, and wastewater, Solid Waste Management, transport, social, performance, assessment and also it has received like a considerable this is score minimizing impact. So, these are two major sets of criterias.

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GRHA Large Development Resource Impact		
Instructions	Maximum Impact	Reduction in Impact
Site Planning		
Adopt site planning strategies to ensure that the overall ambient outdoor temperature, before and after construction, does not change.	100	96
Energy		
Reduce the total amount of energy (kWh) required from the local Utility grid/Ceiling fans by at least 25 per cent.	100	37
Reduce the total amount of energy (kWh) required from the local Utility grid/Ceiling fans by up to 100 per cent.		
Scale: Impact reduction for 100% dependence on local utility grid/Ceiling fans is 0 and that for no dependence on local utility grid/Ceiling fans is 100. The project may enter any number between 0 - 100. For example, if a project draws 60% of its electricity (as compared to GRHA L3 base case) from the local utility grid/Ceiling fans, then the impact reduction to be entered is 100 (0 + 40%).		
Water and waste management		
Reduce the total amount of water required from the local Municipal supply/groundwater by at least 25 per cent.	100	30
Reduce the total amount of water required from the local Municipal supply/groundwater by up to 100 per cent.		
Scale: Impact reduction for 100% water dependence on local Municipal supply/groundwater is 0 and that for no dependence on local Municipal supply/groundwater is 100. The project may enter any number between 0 - 100. For example, if a project draws 40% of its water from the local Municipal supply/groundwater, then the impact reduction to be entered is 100 - 40 = 60%.		
Solid waste management		
Treat all organic waste being generated on site.	100	100
Scale: Impact reduction is 0 if all the organic waste being generated on site is sent to Municipal landfills. If all organic waste collected on site is treated, then the impact reduction is 100. Please enter any number from 0 to 100 in the column.		

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Source: GRHA
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Further in the detail, we will see over here, how much this project has feared on the finer criteria sets, under these sections. So, this you see this section of like site planning over here. Under this section, there are two criterias and under the section of energy there are like three criterias. Similarly, water and waste management has like three criterias, solid weight management here has like one criterion.

So, this is how it has feared. So, the reduction in the impact we can see like here it is able to reduce by like a 96, here it is able to reduce on the energy for like a 37 only, and waste and water management it has reduced up to like a 30, and solid waste management in these criteria it has received like 100 reductions in the impact.

So, you see like we can understand over here from since the location of this site is in such a like a tough climate and that is why they have to rely on the like electrical gadgets for like a comfortable creating like a comfortable environment. So, that is why dependence on electricity is reflected from like this parameter.

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GRIHA Large Development
Environmental Quality

Instructions		Maximum ImpactPoints	ImpactPoints
Site Planning			
Storm water management			
Ensure that the storm water management plan on site is developed such that the post-development peak run-off rate and quantity from 5-year 24 hour design does not exceed the pre-development peak run-off rate and quantity.		30	30
Ensure incorporation of Sustainable Urban Drainage Systems (SUDS) and other storm water management strategies in site planning to ensure that 80 per cent of total solids, 95 per cent of filter and at least 90 per cent of hydrocarbons are removed from the storm water.			
Maintain existing site features			
Ensure that more than 25% of the site area under existing natural features on site like water bodies, dense, multi-species tree clusters and contours with slopes greater than 1:4 are preserved.		10	30
Ensure that more than 50% of the site area under existing natural features on site like water bodies, dense, multi-species tree clusters and contours with slopes greater than 1:4 are preserved.		20	
Ensure that more than 75% of the site area under existing natural features on site like water bodies, dense, multi-species tree clusters and contours with slopes greater than 1:4 are preserved.		30	
Manage construction activities in a manner to reduce environmental damage			
During construction, preserve and protect all the natural drainage channels on site.		10	10
Confine construction activities to pre-designated areas (staging) and adopt soil erosion and sedimentation control strategies (during construction) on site.		10	10
		20	20
New plantation on site			
Increase existing vegetation cover on site more than 25% by ensuring plantation of native trees and shrubs.		10	0
Reapply top soil in more than 75% of the landscape areas.		10	0
		20	0
Total - Site Planning		100	30

Source: GRIHA

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Further detail wise, this calculation you can see over here, this data is also available on the GRIHA website you can go and download this data from there you can understand and you can analyze point by point like how much of evaluation, this project has received on these criteria.

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Energy			
Outdoor street and security lighting			
Outdoor street lighting meets the required criteria.		10	10
Automatic switching/dimming controls to be provided for all outdoor lightings.		10	10
		20	20
Smart Meter Grids			
Implementation of smart energy resources with prioritization to Renewable Energy Sources (RES) and dynamic balancing of energy supply and varying energy efficient loads of the Smart Grids.		10	0
Real time remote monitoring and control of smart metering with user interface which supports remote trouble shooting and alerts.		8	0
Demand Side Management and automatic control of loads used for common services like street lights, water pumps etc., based on predefined criteria.		7	0
		25	0
Passive urban design			
Design, massing and layout of buildings have been done in a manner to shade common areas during peak summer months while enabling shading of roof areas being used for installation of solar photovoltaic. - All 10 points if measures are implemented for the entire site.		10	5
Natural elements have been uniformly interspersed across the site to moderate outdoor temperature. - All 10 points if measures are implemented for the entire site.		10	0
Street layout and buildings have been designed to provide maximum obstruction to local wind flow. - All 10 points if measures are implemented for the entire site.		10	10
		30	15
Operation and Maintenance			
A dedicated operations staff for Operation and Maintenance of Electric-mechanical systems on site.		5	5
Operation and maintenance protocol to be established and implemented.		10	10
Periodic energy auditing (once year) to be carried out.		5	0
		20	15
Total - Energy		100	30
Water and waste management			
Quality of water			
Ensure the quality of potable as well as non-potable water complies with relevant BIS standards.		20	20
Ensure the quality of captured rainwater for storage and recharge as well as recycled water for site usage with the relevant BIS standards.		15	15
		35	35
STP/waste water treatment facility should meet the CPCB norms		10	10
Recharge water filling on site (besides that which is being stored for reuse) is recharged through appropriate filtration measures. - 20 points if the measures are implemented for the entire site.		20	20
All fixtures on site - In all buildings - (W.C, urinals, showers and kitchen and laundry basins) should be low-flow fixtures.		10	10
Establish an effective monitoring systems like SCADA as well as an Operation and Maintenance Protocol for the various plumbing and water treatment systems (both centralized as well as decentralized) on site.		20	10
		20	10
Total - Water & Waste Management		100	90

Source: GRIHA

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Solid Waste Management		
Handling and treatment of special waste		
On-site incinerators to be provided for treatment of medical / hospital waste or provision for the same to be sent to a treatment facility, if applicable.	20	20
Provide contractual tie-up with waste recyclers for purchase and safe recycling of e-waste.	15	15
Segregation and storage of waste on site	35	35
Provision for hygienic secondary storage facility for organic and recyclable inorganic waste collected at site.	20	20
Provide contractual tie-up with recyclers for purchase and safe recycling of inorganic recyclable waste like metal, plastic, paper, etc. from site.	15	15
Construction and demolition waste management		
Develop a construction waste management plan, for safe handling and organized storage of construction waste. To be provided to the site engineer and implemented on site.	15	15
Adopt strategies to recycle and reuse construction and demolition waste on site.	15	15
Total - Solid Waste Management	100	100
Transport		
Provision of footpaths and/or bicycling tracks and for safe interaction of NMT traffic with motorized traffic		
All roads should have footpaths/biceways and cycle tracks.	10	10
Footpaths, sidewalks and cycle tracks should be continuous, wide and universally accessible.	10	10
Supporting infrastructure and facilities like bicycle parking, landscaping, public conveniences, etc. should be provided on site.	10	10
Supporting infrastructure and facilities like bicycle parking, landscaping, public conveniences, etc. should be provided on site.	10	10
Necessary physical safety measures like railings, non-slippery surfaces, etc., must be taken on site.	10	10
Road network planning	40	40
Street network planning to be done in a manner to promote safety, community living, efficiency, walking and cycling.	20	20
Measures to control speed of vehicular traffic should be implemented on site.		
Parking for cars and two wheelers	10	10
Total parking area allocated for cars and two wheelers should not exceed the area required by the local law enforcement authority norms.	10	10
Collective transport services		
Running collective transport services (route, stops, frequency and capacity) for intra-site movement as well as to provide connectivity to the nearest city public transport nodes.	15	15
Electric charging infrastructure for vehicles		
Electric charging infrastructure provided for at least 10% of cars and bikes parked on site.	15	15
Total - Transport	100	100

Source: GRHA

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Social		
Facilities for construction workers		
All safety norms of ISIRI 2008 must be implemented on site during construction.	10	10
All construction workers must have access to clean drinking water and hygienic toilets on site.	5	5
Accommodation facilities for the construction workers must be clean, hygienic, with access to clean drinking water and toilets.	10	10
Child labour should be banned on site.	5	5
Social infrastructure in development	30	30
Design of the development should be done according to guidelines on universal accessibility, including provision of disabled-friendly public toilets.	10	10
Identify smoke/tobacco free zones on site.	5	5
Create environmental awareness through imparting information like display boards, panels etc.	5	5
Provision of dedicated resting areas and toilets for service staff as per GRHA LD threshold.	10	10
Planning for low-income group population - Non-Applicable for SEZ and Educational campuses	30	30
EWS housing should be provided on site.	5	0
Health centres and schools - reserved for lower income group - should be provided in the development as per Urban Development Plans Formulation and Implementation (UDPF) guidelines.	10	0
Planning to also consider adequate provision for informal market.	5	0
Food production on site	20	10
Plan food production for more than 5% of the total landscape area or equivalent (vertical farming etc.)	10	10
Plan food production for more than 10% of the total landscape area or equivalent (vertical farming etc.)	20	0
Total - Social	100	70

Source: GRHA

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So, this entire documentation is given over here for your understanding.

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Why Confined Masonry?

- Confined masonry buildings are expected to have better earthquake performance than unreinforced masonry wall construction and reinforced concrete (rc) frames with infills. The site is located in Seismic Zone III per the Indian seismic code IS: 1893, which implies a shaking intensity of VII (MSK Scale). Gujarat has experienced devastating earthquakes in recent history, including in January 2001 when the Bhuj earthquake (magnitude 7.7; maximum shaking intensity X) struck the Kutch region of Gujarat and caused huge human and economic losses. The death toll was 13,805. Approximately 130 RC frame buildings in Ahmedabad collapsed leading to a death toll of 805.
- Evidence from numerous earthquakes in other countries indicates that good seismic performance can be achieved with confined masonry even without a high level of engineering, provided the quality of construction is maintained. For this reason it was decided that residential buildings at the IITGN Permanent Campus would be constructed in confined masonry.

Source: IIT Gandhinagar

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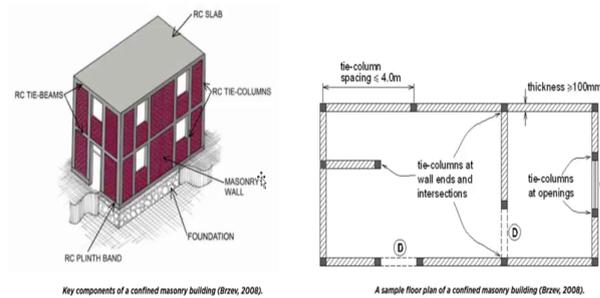
So, now, from here onwards, we will discuss the what kind of design and approaches they have utilized in this project. So, they have used this confined machinery construction technique. So, the confined machinery buildings are expected to have better earthquake performance, then unreinforced machinery wall construction and enforced concrete, frames with infills.

The site is located in seismic zone 3 as per the Indian seismic code, which implies a shaking intensity of like a 7 MSK scale. Gujrat has experienced devastating earthquakes in recent history, including in January 2001 when the Bhuj earthquake magnitude of 7.7, the maximum shaking intensity of 10 struck the Kutch region of Gujrat and caused huge human and economic losses. The death toll was the 13,805.

Approximately 130 reinforced concrete frame buildings in Ahmedabad also collapsed leading to a death toll of 805. Evidence from like a numerous earthquake in other countries indicate that good seismic performance can be achieved with confined machinery even without a high level of engineering, provided the quality of construction is maintained. For this reason, it was decided that residential buildings at the IIT Gandhinagar permanent campus would be constructed in confined machinery.

So, this is a personal, I think an expert decision from the director of IIT Gandhinagar and his team, that he himself is a civil engineer. So, that that is why they decided to go for this construction method with a constant monitoring to control the quality of the construction on the campus.

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Key components of a confined masonry building (Brzev, 2006).

A sample floor plan of a confined masonry building (Brzev, 2006).



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So, these are some details given about this the confined machinery structure on their documents you can see over here. The details you can see from the documents. So, this is the segmentation you can see in these walls. So, there is like n number of segmentations even these windows and openings they have their own proper like individual like segmentations, in order to minimize the stresses on these joints, because in the event of like any earthquake like these trimmers, these joints are more vulnerable and are prone for like ruptures and fractures and cracks. So, for whether it is like a shear or any like a kind of like a strain, they have taken care of through like this design.

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Building Materials on the Site

- Building materials used on the project were typical for rc and masonry construction in India: cement, sand and coarse aggregate, bricks, and reinforcing steel. maintaining a continuous supply of bricks of required specifications presented a challenge due to the project scale. A few creative approaches were followed to meet these challenges, including building a plant on site to manufacture the FALG bricks that were needed because of their higher compressive strength. Burnt clay bricks were also used; the use of these two different types of bricks was beneficial in expediting the project.

Fly Ash Lime System



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Source: IIT Gandhinagar
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About building materials on the site. Building materials used on the project were typically for like a rc and machinery reconstruction in India, cement sand coarse aggregate, breaks, and reinforcing steel. Maintaining a continuous supply of bricks of required specifications presented a challenge due to the project scale, a few creative approaches were followed to meet these challenges, including building a plant on site to manufacture the FALG bricks, FALG means fly ash lime gypsum. So, that was needed because of their higher compressive strength. Burnt clay bricks were also used, the use of these two different types of bricks was beneficial in expediting the project.

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2.1. Bricks

Virtually every building on the campus required bricks for masonry construction. Staff housing and student hostels are load-bearing confined masonry structures, while academic buildings are RC frame structures with brick masonry partition and exterior walls. Higher compressive strength bricks were required for above grade confined masonry construction, but lower strength bricks were acceptable for foundation construction and masonry infills in RC frame buildings. As a result, there was a significant demand for bricks - on the order of 100,000 bricks per day. A preliminary survey of local brick manufacturers performed by CPWD engineers showed that it was not possible to procure a sufficient amount of clay bricks of the required quality in the Ahmedabad area. For this reason it was decided to use special Fly Ash Lime Gypsum (FALG) bricks due to their availability and higher compressive strength. The project team set up a plant for manufacturing FALG bricks (capacity 65,000 bricks/day) at the construction site. The bulk quantity of fly ash needed was available from nearby thermal plants. Clay bricks and FALG bricks used on the IITGN project are shown in Figure 20.




FALG bricks had a higher compressive strength than burnt clay bricks, however they also had higher water absorption; this was a concern for below grade masonry applications. Therefore, FALG bricks with a class designation 9.0 MPa as per CPWD Specifications and a maximum 12% water absorption were used for above grade construction, while foundations below the plinth level were constructed using burnt clay bricks with a minimum compressive strength of 5.0 MPa and a maximum 15% water absorption. FALG brick properties were in compliance with IS 12894:2002, and regular testing was performed in a laboratory set at the manufacturing plant.

The use of two different sources for brick supply was also beneficial for expediting the project. The manufacturing process is illustrated in Figure 21. Initial testing of the mechanical and physical properties of the bricks used on the project was performed at IIT Kanpur (Rai, 2013).

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Lecture 4: Technological Interventions into building design
Course: Strategies for Sustainable Design

Source: IIT Gandhinagar

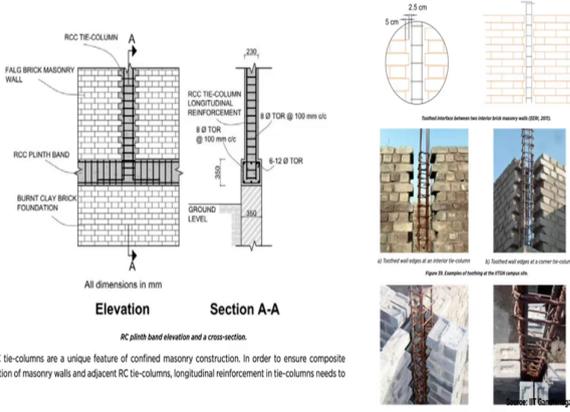
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So, you can see the details of FALG bricks over here, fly ash lime gypsum, you get the picture is on the right side, you see the like this brick is of FALG and this is the conventional red brick of like a clay burnt brick. So, manufacturing facility of this FALG brick was erected on the campus. So, that our continuous and unhindered supply of this brick material can be ensured because this is not usually available in the market outside and as like a raw material, they used fly ash from the nearby thermal power plant because Gandhinagar has its own like a power facility, it is like a thermal power plant you can see in the pictures. So, they utilize this raw material which was readily available on this power generation plant.

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All dimensions in mm

Elevation Section A-A

RC plinth band elevation and a cross-section.

RC tie-columns are a unique feature of confined masonry construction. In order to ensure composite action of masonry walls and adjacent RC tie-columns, longitudinal reinforcement in tie-columns needs to

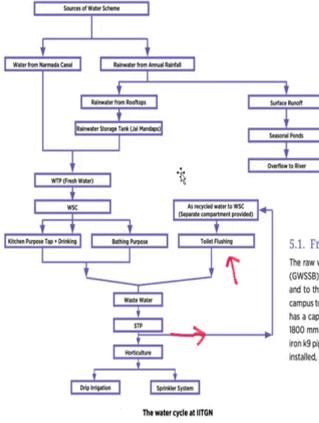
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Further these are some sketches of this confined brick mastery system. So, you can see like how these reinforcement bars are laid in between these two sections of this wall and these are rugged these two-thirds, these are brick forms these layers have this a tooth like arrangement and how it will create our (())(27:03) formation inside once the concrete is pulled. So, this is a technique they have adopted to counter the high risk this seismic zone of India.

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5.1. Fresh water from the Narmada Canal

The raw water from the Narmada Canal is supplied by the Gujarat Water Supply and Sewerage Board (GWSSB) from a pipeline that presently transports water from the Narmada Canal to Gandhinagar City and to the thermal power plant at Gandhinagar. A new tributary pipeline was laid specifically for the campus to bring water from the main Gandhinagar City pipeline. This dedicated pipeline is 8 km long and has a capacity to bring 4.6 million litres per day to campus. Tapping has been done from the existing 1800 mm Dia MS water supply line of Narmada Canal at Dhoikava Circle. A 300 mm diameter ductile iron K9 pipe has been used to connect the WTP with the existing supply line. Two flow meters have been installed, at the starting point at Dhoikava, and at the end point at the WTP.

The water cycle at IITG

Source: IIT Gandhinagar

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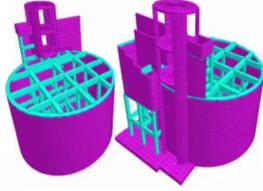
In the next slide here, you can see the water cycle adopted at IIT Gandhinagar So, like a source of like a from the water from here if you see, water from the like a Narmada canal and rainwater. So, how well water from the Narmada Canal goes for the like an expected, this is like a usage and recycling. But rainwater from the annual like this rainfall, the total rainfall

collected over the year it goes like starting from like a roof top to the like a surface runoff. So, it is divided into two.

So, the rooftop water is taken into this Jalmandap directly because it is relatively much cleaner than the surface runoff and then it goes for like converting into the like a fresh water in and water for like a different consumption even for like drinking, bathing and other purposes. And then the water from this surface runoff is taken for to the seasonal points and or maybe for the like a runoff to the river.

Finally, like from the STP you see there is like a feedback cycle given over here. So, this water after layer this STP goes for like recycling to the like a for more purposes even use for like a toilet flushing also and then the even the wastewater coming out of this waste, like these STP will go finally for the like a horticultural like a progressive or like a drip irrigation and like watering the plants and agriculture on the campus.

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Source: IIT Gandhinagar

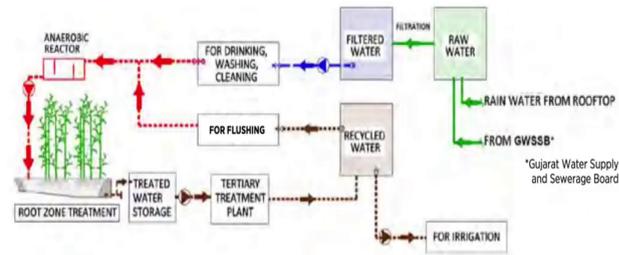
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So, these are the pictures on the left of this Jalmandap, is the centralized water harvesting facility on the campus of IIT Gandhinagar and then you can see the 3d sketch of this gentleman over here.

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Decentralised Wastewater Treatment System (DEWATS): Water management system on site



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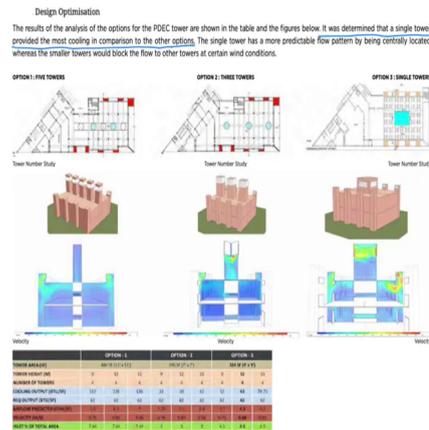
Source: IIT Gandhinagar

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So, this is the diagram of decentralized wastewater treatment system adopted on this particular site of IIT Gandhinagar. So, you can see from here the rainwater, the rainwater from the rooftop and the Gujarat this water supply and sewerage board, from the river, how it goes the further it goes for the filtration in a treatment etcetera. For drinking dishwashing and other like a utility activity, and this recycled water goes for like flushing works and the irrigation and like other things. So, you can see how this they have tried to close the cycle.

So, the wastewater generated from this flushing and the liquid drinking and washing and other like utility things, it goes for anaerobic reactor it gets like a filtered on its own like unnaturally then it goes for like further like a treatment etcetera. Then again it comes for like either recycle water and then it goes for the flushing. Finally, if it is not going there then the final like this the wastewater goes for the like irrigation purposes. So, this is what recycle adopted on the site.

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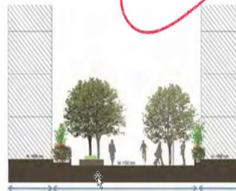
Further like a design optimization they have conducted several analytical exercises, simulations etcetera to come up with the final form and structure of the buildings constructed in this campus, you see one of the optimization analyses exercises for the residential areas for students and the staff and faculty over here. So, the how many numbers of towers are needed for this passive cooling up there.

So, you can see it was determined that a single tower provided the most cooling in the comparison of the other options, you see here are three configurations. So, the first one has like the 5 towers, the second has 3 towers and the last one has the only 1 tower. So, it was found with this analysis, the single tower is structure is more efficient compared to these ones. So, this was finally followed on this campus.

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Shadow of neighbouring building used to shade the ground and first floor windows. The windows on the third and fourth floors angled to avoid the direct rays of the sun



Street view - Old city Ahmedabad

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Energy Efficiency

The efficient use of energy was a key design criterion. Shading and lighting studies were conducted to help orient buildings on the site and in relation to each other. Windows were designed with deep recesses and orientations that maximised shade. A passive cooling system (Passive Downdraft Evaporative System) was designed for the mess, to be used primarily in the four hottest months. Hostel energy consumption is monitored each month, and a competition among the hostels is held to see which is the greenest.

Source: IIT Gandhinagar

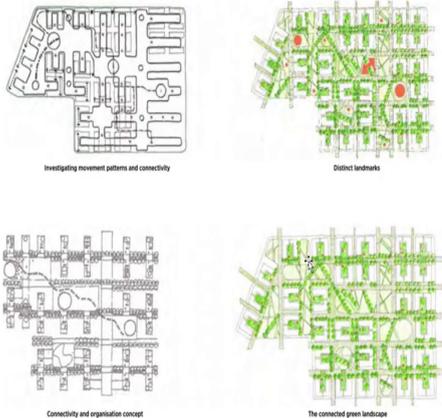
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So, this is what I was talking about, they have taken cues from the vernacular architectural system of this Gujarat particularly the city. So, you see the picture on this left, this is a typical image, a typical picture from the residential neighborhood which are called like a hole and the market areas collectively they call them old sand poles. So, this is a typical picture you see, how these overhangs, how these cantilever structures are partially covering these walkways over here, these alleys over here, reducing the exposure to the sun.

And with the stack effect, there will be an induced wind movement in this thing, and relatively it remains like a cooler compared to the upper parts of the buildings. So, this was philosophy used in creating such designs over here. You see this is a shot or this is an image from like a residential area and also narrow openings and walkways they created to replicate this effect over here. Finally, bringing down the energy consumption and increasing the energy efficiency.

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Investigating movement patterns and connectivity

Distinct landmarks

Connectivity and organization concept

The connected green landscape

Source: IIT Gandhinagar

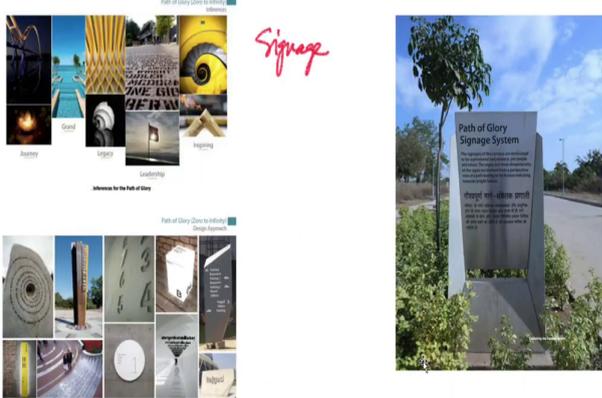
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This slide elaborates on the of the conceptual approach they have taken for like the creating the vegetation and planting the trees and bushes and shrubs and plants on the campus. So, these are residential blocks. So, this is how based on the prevailing wind movement and the sun direction, they have planted the vegetation.

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Path of Glory Signage System

Path of Glory Signage System

Source: IIT Gandhinagar

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For the signage also special attention is paid, they have derived special a dedicated signage system for this campus. So, that the signage system can be in place which will help the any outsider or even any resident of this campus for like easy navigation to the campus.

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Flora and fauna
Fertile agricultural land, severely eroded into ravines at several locations, is characteristic of the existing landscape. The vegetation pattern on-site consists of:

- Large neem and mango trees found mostly in the flat areas of the site.
- Ravine thorn forest, with thorny scrub interspersed with neem and acacia, found on the edges and within ravines.
- The herbal garden area, planted with neem trees.

Source: IIT Gandhinagar
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Flora and fauna, you see this is the layout which clearly the markets the ravines' structure. So, these blue areas you can see from here the you see this detail from here. So, up to like these areas, the water in the flooding season reaches till these levels. So, these areas are left like that, for natural habitation to continue as it is. So, this is a scheme devised for helping the flora and fauna on the canvas.

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10 Sustainable Design

10.1. Elements of green campus design

Green campus design in India, in fact the world over, is a poorly understood area. While the issue really ought to be about sustainable campus development (Figure 38), it is often confused with green building certification. Four new standards have emerged recently:

- 'Approach to Sustainability' has been added to the National Building Code of India.
- IGBC Green Township Rating System.
- GRHA guidelines for Green Large Area Developments.
- The Energy Conservation Building Code.

10.2. Land use

The carrying capacity of the campus has been determined by the permissible Floor Space Index (FSI). IITGN will not be able to use all the FSI as large green areas are needed for recreation. In addition, substantial portions of the site include the ravines that need to be conserved.



Source: IIT Gandhinagar
Dr. Shiva J
IIT Hyderabad, India

The mandatory requirements for green certification have been met and IITGN become the first campus to be awarded a 5 Star Rating by Green Rating for Integrated Habitat Assessment (GRHA).

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Well, on the sustainability aspects. These are also documents are given on the website and are clearly mentioned how sustainability they have, how they have achieved a sustainability on this campus, so these are given in these are like a finer detail's elements of green campus

design approach to sustainability. Well, they have utilized the state-of-the-art listed, literature and other resources available from like NBC.

So, this is talking about the NBC over here. Approached to sustainability, this is the part 11 of the NBC 2016 we are talking about has been added to the NBC code of India. IGBC green township rating system, GRIHA guidelines for green large area development LD, the energy conservation building code ACBC that all of these things we have discussed in our previous lectures.

So, all of these resources which are the best resources possible for designers and architects and engineers to practice in this field today. So, they have utilized all of these resources for the design and development of their campus. For the land use, the carrying capacity of the campus has not been determined by the permissible floorspace index, if it is high. IIT Gandhinagar will not be able to use all the FSI as large green areas are needed for recreation. In addition, substantial portions of the site include the ravines that need to be conserved.

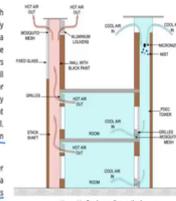
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10.3. Socio economics

One way in which the relationship with Palaj village has been handled with sensitivity is in the boundary wall between the campus and the Palaj village. Early on in campus development it was decided that it would be necessary to build a boundary wall to delineate the village from the campus. In order to not offend the villagers, however, it was decided to build a low-rise, undraining wall, so villagers might be able to cross the wall easily so as to enter the campus premises. This wall ensure that they could continue to enter the area that they have had access to for decades, and yet they will start to recognize the line from which IITGN properly starts. The foundations for the boundary wall were designed for the full height wall so that in case a need arises in the future, IITGN could add height to the wall. The current low-rise wall gives the message that both village and campus can co-exist.

During the first phase of construction, there was a lot of emphasis on worker welfare and safety. Nurseries were provided for very young children so they had a place to go while their parents worked, workers were required to wear hard hats (with some evidence that this increased the quality of workmanship), and they were provided with very good masonry housing on-site.



10.4. Energy efficiency and renewable energy

While energy efficiency is primarily a building specific issue at the campus level, the major goal is to reduce the use of vehicles to and from, as well as on the campus. The campus layout has been designed to encourage walking and to discourage vehicular use. As the north site is developed further, an electric bus service may be used. The main modes of transport on the campus are walking and bicycling.

The hostel dining halls and several classrooms in the academic area have been installed with passive downdraft evaporative cooling systems (Figure 39). These systems spray a fine mist of water at a height resulting in cooling of air (in dry weather), and this heavier cool air flowing down to the classrooms or dining halls, under gravity. These systems use no fan or power except for spraying a fine mist of water, and are effective for a warm and dry climate such as in Gujarat for



Source: IIT Gandhinagar

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Socio economics, if you see the current low riser wall gives the message that both village and campus can coexist. This the one point I was mentioning initially and also the boundary wall between the Palaj village and the IIT Gandhinagar campus is intentionally kept low and porous. So, that a visual connection or an emotional connection will still be able to continue. Even, if this IIT Gandhinagar has come up, but they are not closing it suddenly and they are still allowing this interaction to keep continuing over the lack of time.

Energy efficiency and renewable energy. So, the main mode of transport on the campus is like walking and cycling and a passive downdraft evaporative cooling system, you can see in this image over here are used in the residential areas the one analytical figure I was discussing in the previous slides. Spray of fine mist of water at a height resulting in cooling of air.

So, this as I said like this place is a very dry area. So, in this one of the dry months you need like a humidification. So, these water mist, you know these sprinkler systems are placed in like these complexes, where it emits the fine mist bringing down the harsher effects offer dryness in the air by creating a humid and a pleasant atmosphere.

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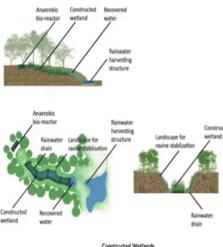


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a few months in the year. The energy consumption is therefore drastically reduced. These systems are also supplemented by night purge systems, cavity walls, passive shading devices, use of natural daylight, and insulation (Figure 40).

10.5. Water and waste water management

The efficient use of water is important at both the building and site level. The intent is to harvest rainwater and use it in the buildings. Waste water is being treated through anaerobic bio-reactors and through constructed wetlands (vertical flow) (Figure 41). This system is very energy efficient and it makes use of the space available in the ravines. Treated effluent is used for landscape irrigation. The plant material selected for the landscaping is water conserving.





Harvested water retaining structures are an important functional and visual element of design on the campus, as are the Water Service Centres. Another source of water that is being exploited is flood water that naturally comes into the lower reaches of the ravines on-site. Harvested rainwater and collected flood water can be used for all construction-related water requirements of the site.

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Water in wastewater management. The intent is to harvest rainwater and use it in the building. Wastewater is being treated through anaerobic bio reactors and through constructed wetlands, vertical flows. So, you can see over here these are ravines and these natural topographical formations are used for like a rainwater harvesting and retaining the water in the ground for like a groundwater discharge etcetera.

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10.6. Solid waste management
The solid waste management system has been designed to allow on-site recycling of biodegradable materials and the transfer of recyclable materials to regional commercial recycling centres.

The waste generated during the construction phase is being used on-site to fill designated isolated pockets of land within the site.

10.7. Facility maintenance
The campus requires maintenance and has outsourced this service. However, on-site facilities have been provided for storage for material to be recycled and/or transferred to designated off-site facilities, as well as a maintenance workshop and maintenance material stores.

10.8. Monitoring and control
The campus of IITGN has many different systems for the management of energy, water, daylight, ventilation and cooling systems. The different systems are connected by an Automated Monitoring and Control System. In the initial stages, the system generates primary data that will be used for further optimization at later stages of development. It will also provide an automated control facility.

The campus has a fibre optic network that allows all buildings to be connected by the Automated Monitoring and Control System, thus making IITGN a smart campus.

10.9. Adaptation/ risk mitigation for climate change
There are two elements of climate change that may require adaptation at IITGN: increase in temperatures and change in precipitation patterns. The system of Passive Downdraft Evaporation Cooling (PDEC) should provide relief from higher ambient temperatures and eliminate the need to resort to air conditioning in non-air-conditioned areas of the campus. For changes in rainfall and water availability, large water storage structures will allow the campus to adapt to short-term disruptions in water supply.

A distinctive element of one of the academic buildings, Building 7, was suggested by the Masterplan's recommendation to use architectural design features to help cool the buildings and to monitor the effectiveness of various approaches. As described in more detail in a separate report in this series, Building 7 has a building management system in place that will allow campus staff to monitor the various cooling techniques that are being used in that building over time. In the future, these data can be shared with researchers and designers and used to help determine which techniques might be most appropriate and effective for future buildings.

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For the Solid Waste Management, on site recycling of biodegradable materials and the transfer of recyclable materials to regional commercial recycling centers. So, they have their own like I said earlier, on site biodegradable material recycler unit on the campus. So, there is no kitchen waste or any organic waste, which goes outside of this campus, the only solid waste which cannot be recycled on the campus that only goes to the designated recycling units, for the recycling and other purposes. So, they have taken care of like a facility maintenance, monitoring, and control, and adaptation, and risk mitigation for the climate change etcetera.

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Green waste Recycling



Explaining the segregation of waste



Explaining the Biogas plant



Building using the biogas plant



Root Zone Treatment system, where *Canavalia indica* plant roots absorb pollutants from effluent, as part of sewage treatment process



Compost pit



Source: IIT Gandhinagar

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So, these are important factors, which we come across through this case study. So, these are some images you can see like this green waste recycling plants like how is it functioning, how the staff of this campus this institute are volunteering themselves with this common cause this intent to continue this moment of like a sustainability on the campus.

You see some images of like, this biogas plant over here, this root zone treatment center, we are a canna indica plant roots absorb pollutants from like effluent as part of the sewage treatments process, this is conventional method of water treatment and filtration systems. So, that is also employed on the campus. And on the right side, you can see like our designated waste bins are kept at different places for like a garbage collection, and compost pit is also there on this right side, you can see in this image.

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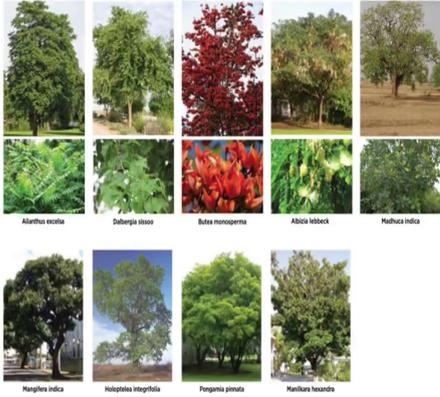
The collage features the NPTEL logo at the top left. It contains two photographs of classroom environments where students are engaged in learning. A third photograph shows a rural building with a blue text overlay that reads: "Building for Construction Workers" and "The Institute's Constructive Worker Welfare Program". Below the collage is a portrait of Dr. Shiva J. and a slide titled "Week 1: Definitions and Perspectives on Sustainability in Industrial Design and Built Environments", "Lecture 4: Technological interventions into building design", and "Course: Strategies for Sustainable Design".

Well, some more subtle impacts, which this campus is extending in a, like a positive way to the community is by responsibly taking care of the workforce, which is employed on the site, by extending the facility of education, and recreation to these children who are children of these a workforce on the campus, so educating them, taking care of their, like, mental well-being is also taken care of, so that they can become part of the mainstream of the society. So, they are not left out like any other like a generic project, but this project has tried to serve to it is like a social responsibility also.

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Trees in the green connecting spaces



Alnus incana, Dubergia tissoo, Butea monosperma, Albizia lebbek, Maduca indica, Mangifera indica, Holoptelea integrifolia, Pongamia pinnata, Bambusa nana

Source: IIT Gandhinagar

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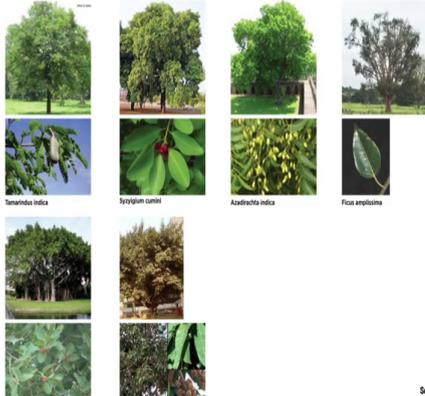


Finally, these are some different species of vegetation trees, flora, which are planted on the campus, these most of these are local, species of these trees and all, and they are flower in certain season, they bloom in certain seasons. So, depending upon the requirement of the space and the places, these trees are planted on the campus.

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16.3. Trees in Central Vista



Tamarindus indica, Ficus religiosa, Azadirachta indica, Ficus amplissima, Ficus benghalensis, Ficus religiosa

Source: IIT Gandhinagar

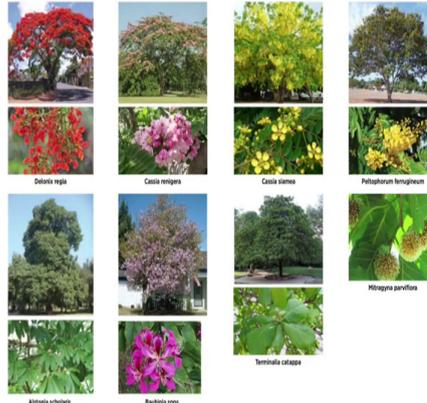
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16.4. Trees in Avenues



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Source: IIT Gandhinagar

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So, you can see like, they have used these many varieties, which shows like a conscious effort, a positive intent to create a green annular habitable space in the IIT Gandhinagar.

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16.6. Trees in Ravines, along boundary



Salvadora oleoides

Acacia senegalensis

Acacia catechu

Bambusa villosa



Prosopis juliflora



Casuarina equisetifolia



Ziziphus maurandia (Berdi)



Acacia robusta



Acacia lucidiflora (Dermi)



Prosopis cineraria (Berdi)



Capparis decidua (Berdi)

16.5. Trees in Ravines

Source: IIT Gandhinagar

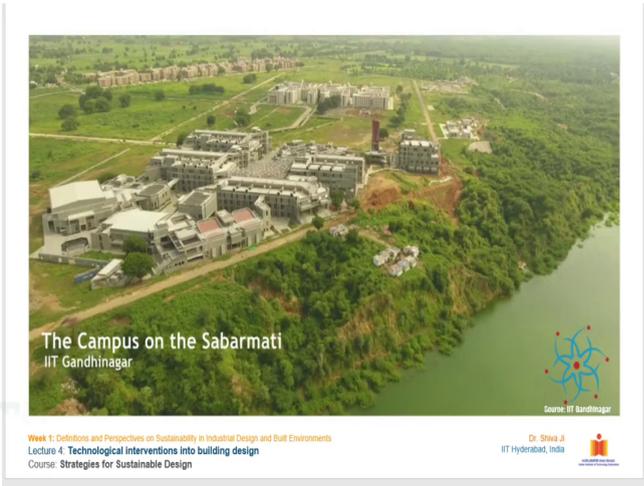
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So, I am sure in the years to come when the campus will grow to it is like a full extent, the habitats of the occupants and the students and the faculty and the staff at those years will cherish, will praise the efforts given by the director and his team in order to make this campus a sustainable one, in a very long run.

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The Campus on the Sabarmati
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So, with this, we have come to the end of this lecture, and I would suggest you visit the website of this IIT Gandhinagar. You can Google some more research material from the website, and you can get more detailed information about this case example, you must be for in your lecture design exercises as a role model as I said earlier. So, with this we have come to the end of this lecture. Thank you, everyone.