Strategies of Sustainable Design
Professor Doctor Shiva Ji
Indian Institute of Technology, Hyderabad
Lecture 41
Case: 3 Design of First Net-Zero Building of India

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Hello, everyone. In this lecture, we will discuss about design of first net-zero energy building of India, that is, Indira Paryavaran Bhavan, New Delhi. So, we will see like, a, the design strategies adopted in this building and how they have achieved this feat which was actually a marvelous achievement in terms of creating the first net-zero energy building of India.

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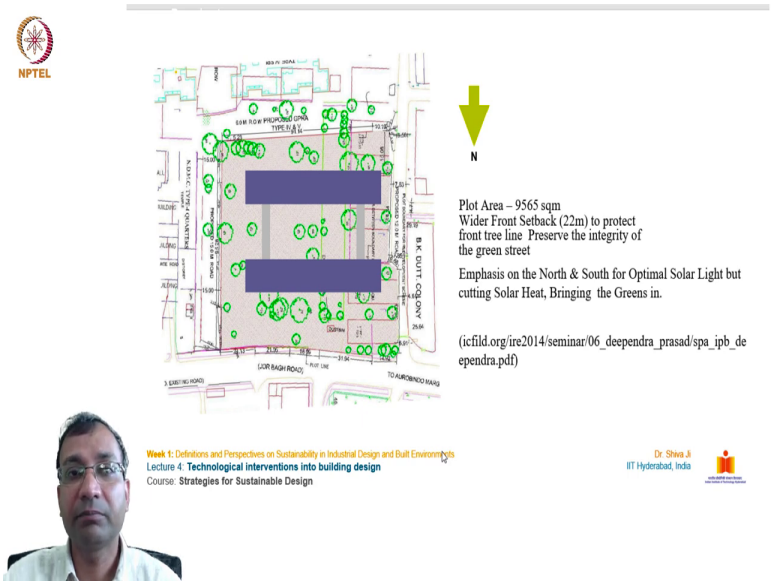

So, the plot area, if you see, like, this has 9,565 square meters. So, this is located in the, bustling, actually, this Lodi Colony area of New Delhi and the side setbacks if you see, it has 22 meters to protect the tree line, preserve the integrity of the green street. So, this is located next to this, you may have heard, this Lodhi Garden area. So, it is in vicinity of that area. So, it is one of the most beautiful areas where there is ample amount of greenery, trees, garden, et cetera, and some like, a historical heritage structure also. So, this had actually the challenge of going with the theme and language of this particular area.

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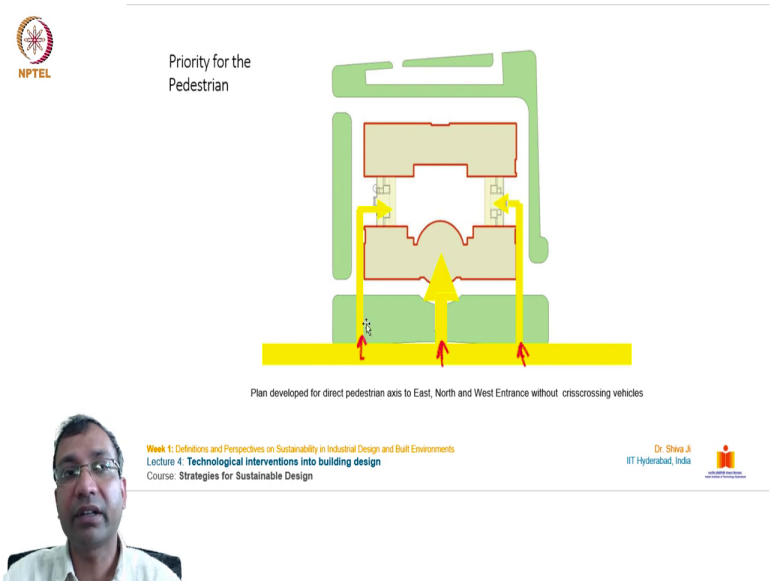

So, how they have actually first brought in the pedestrian, movement on the side is shown through this illustration over here. So, you can see this is the main street and from here, this is the entry to the main building, and these are the two different entries in the podium of the building from like, two different sides.

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So, we have this ground floor plan over here. So, you can see this ground floor is green area with ample open spaces. So, we see four quarters of the occupied building structure and between these four, we have these two crossing, axis of movement. And in this

movement area, there is ample green cover and trees and other, like, plants and some water bodies are actually given over here for creating this ambience, ambient environment in this particular place. So, you see, like based on the utility, we have offices here on this side. We have recreation. These areas are like, recreation. We have this circulation area in the yellow and then we have services in the blue shade.

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This is the basement. So, we the number of parking facility for two wheelers and four wheelers are provided in the basement so there is no ground level parking issue on the ground floor or outside, like property on the main street.

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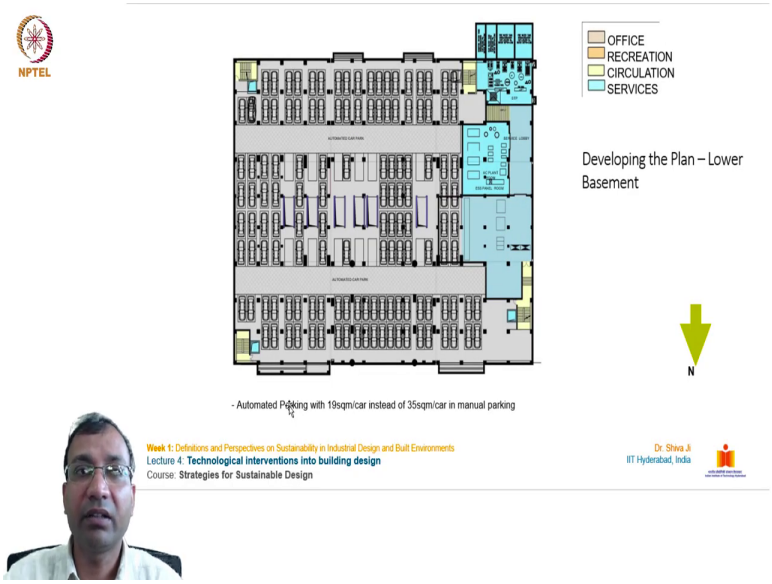

Further, another level of parking in the lower basement.

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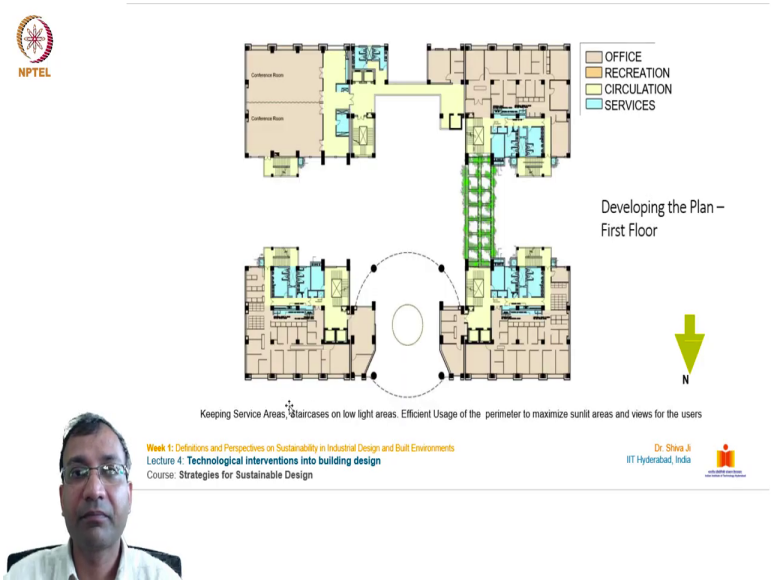

So, the first floor if you see, there, from there, we can see the planning of the internal office areas and service areas and the circulation areas. So, see, there is this connection which is established in these areas through this, this circulation area.

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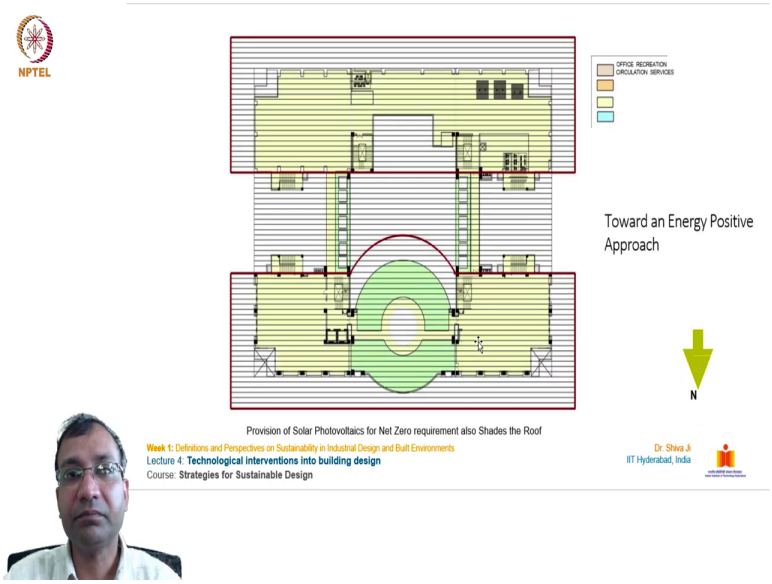

On the top floor, this is taken from, like, a terrace. So, this is where the photovoltaic solar panels are laid on top of this building. So, except like, the portions and little bit in the setback, most of it is covered, is covering this entire footprint of this building and this is used for installing photovoltaic solar panels which generate electricity for onsite consumption of this building as well as there us surplus power generation also which is shared with the national grid.

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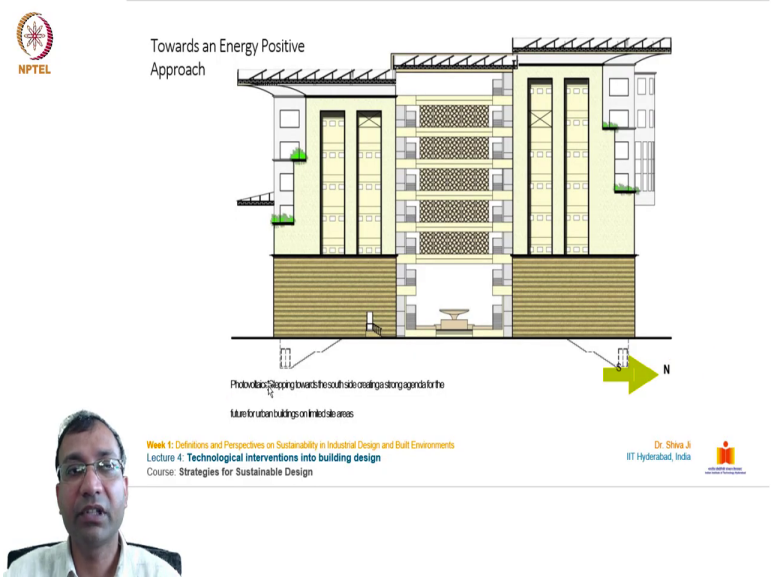

This is the elevation. And also, in this, you can understand how this elevation, in the elevation it is clear that in the stepped fashion they have arranged these solar panels to

maximize the solar gains on these panels from the orientation. So, you can see from this side of course, this has to be North and this side, this is the South so increase the sun on these, these panels. And these panels are actually laid at certain angles so they can maximize the sun's intake. On the elevation, you understand there are nets and openings used and they have terrace gardening also at different floors to actually enhance the, ambient on this premise.

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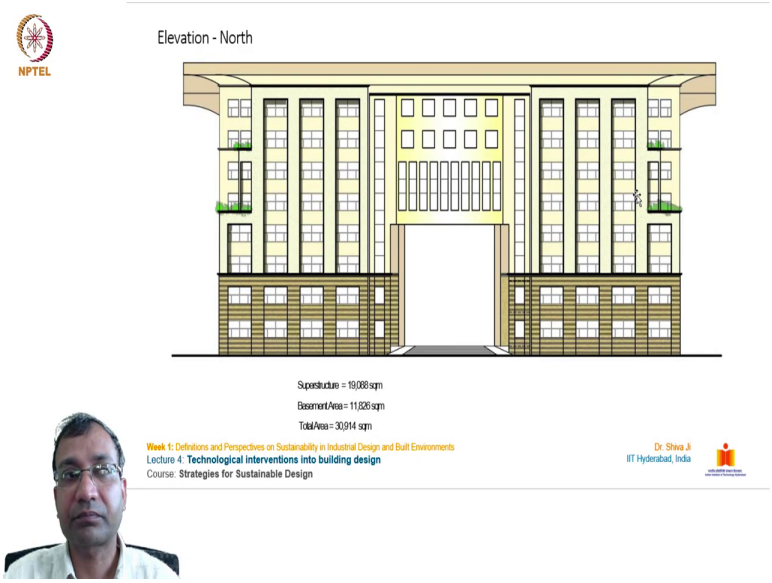

From the North side, which does not actually receive the direct sun, so the number of openings and the size of openings is comparatively wider.

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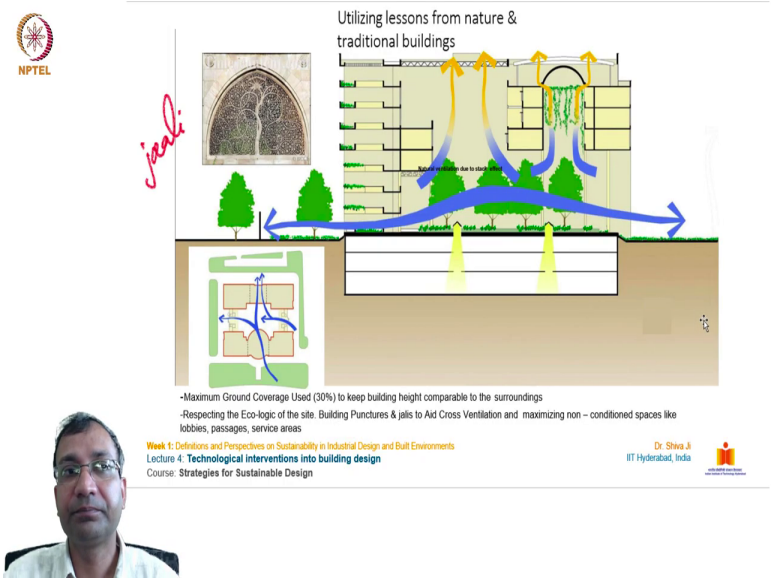

This is the cross-section. So, this is how this building is actually envisioned, utilizing the stack effect to bring in the fresh air from the lower floors and to release the stale air from these roofing from the top. So, this ventilation system is designed to work in the, like, in a fashion of vernacular architectural systems of India. You see this, the Sidi Saiyyed Mosque "jaali" from Ahemdabad, the old Ahemdabad. So, that is given over here. So,

this works as an inspiration for creating, like a “jaali” in the, solid natural materials which actually cools the air, like climatic places, such as, which fall under hot and dry and humid areas.

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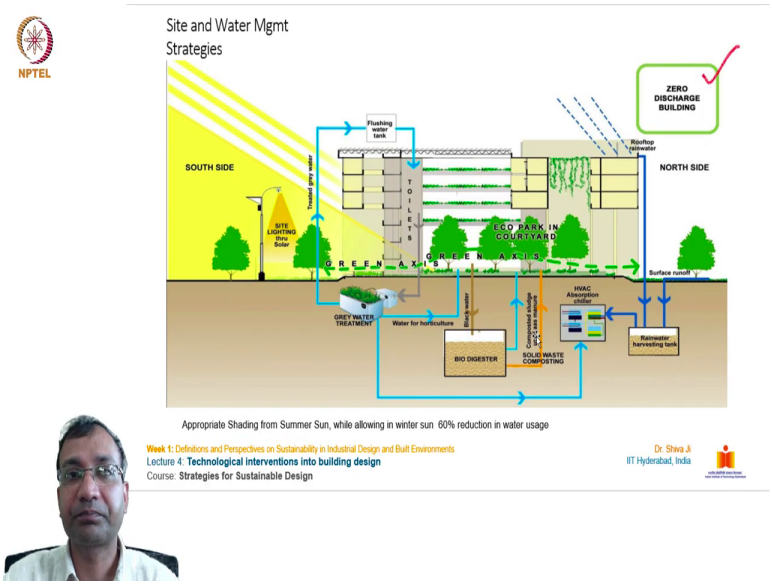

So, this talks about devising the strategies for solar and water management. So, you see how this South side is utilized for these service areas, which are not actually, there are not habitable or, these spaces and these gardens are created at this lower floor, creating this green axis on this side and some creepers are also utilized over here in order to lower the temperature of the air inside the atriums over here.

And then water related services are all laid underground. So, you see from here, like this roof, from the rooftop, this rainwater is getting collected in the rain harvesting tank and all the surface runoff is also collected in this tank. They are actually sent to this HVAC absorption chillers for lowering the temperature.

So, this is how this water is also utilized and the, from this, you see this supply of this grey water goes to the flushing, water tank, in the toilets. From toilets it comes back again for use in the, as a green water treatment over here. From here the water is supplied for horticultural activities also.

And they have actually this bio-digester also in this, underground, in this premise. So, the black water received from these places are collected over here and further this solid waste

composting is used for gardening purposes and sludge is also sent for manure purposes and things like that.

So, there is actually a complete cycle happening on this site and this is one of the zero discharge buildings as you can see over here. So, there is no discharge of water or the waste water from this premise. So, it is not just helping on the energy generation, it is helping even actually in taking care of the other natural elements also such as water.

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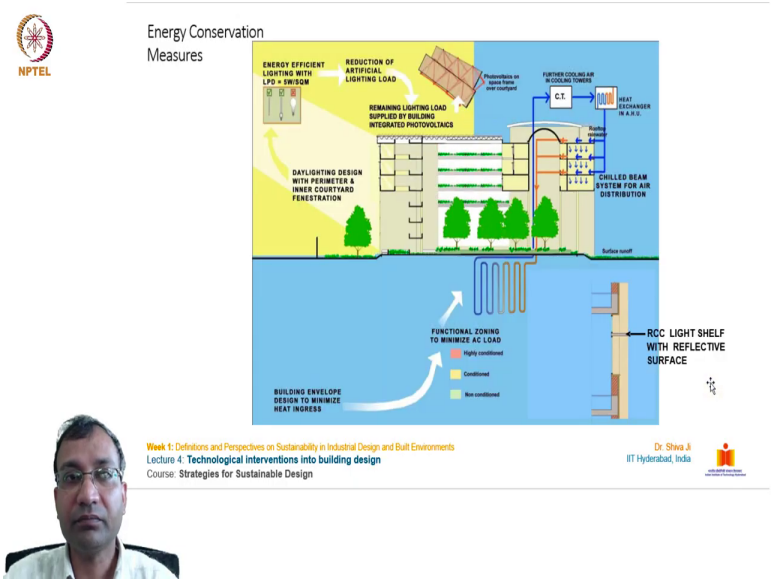

Further, this energy conservation majors are stated over here, in this slide. So, you can understand like how this cooling of this water is being done. So, you can see over here, this energy efficient lighting systems used in the top over here. Reduction of artificial lighting load because remaining lighting load supplied by building integrated photo voltaic and see how the space films are utilized for laying the photovoltaic panels.

And the water if you see, how this water is utilized for cooling towers, heat exchangers in the air handling units over here. The chilled beam is used for the distribution across these sites and further it goes down in the ground and then again it cools and then again it is taken up. And how this RCC, light shelves with reflective surface materials are used over here for reflecting the lights inside the inner spaces. So, this is where, you can see the number of applications for conservation of energy and maximizing the use of the day lighting in this building.

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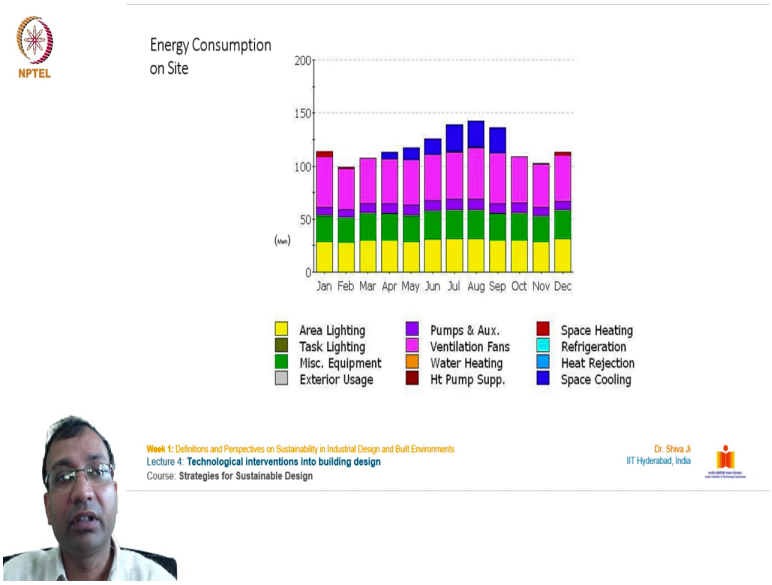

Further, we have this, some form of data over here like how much energy is consumed. On what different activities across the different, these months, you can see.

So, the, the largest one is the dark blue. The space cooling is utilized here in this month of April, May, June, July till September and for the heating, January and December. And rest of the months, it is like, ventilating like fans. This purple color, you can see over here. And the pumps and auxiliary are almost constant around the year. And then we have green like, various miscellaneous equipments, et cetera and then yellow is for the lighting. So, lighting also is increased in these months over here. In this. So, this is actually a chart which depicts like, what kind of energy requirements are there in this building.

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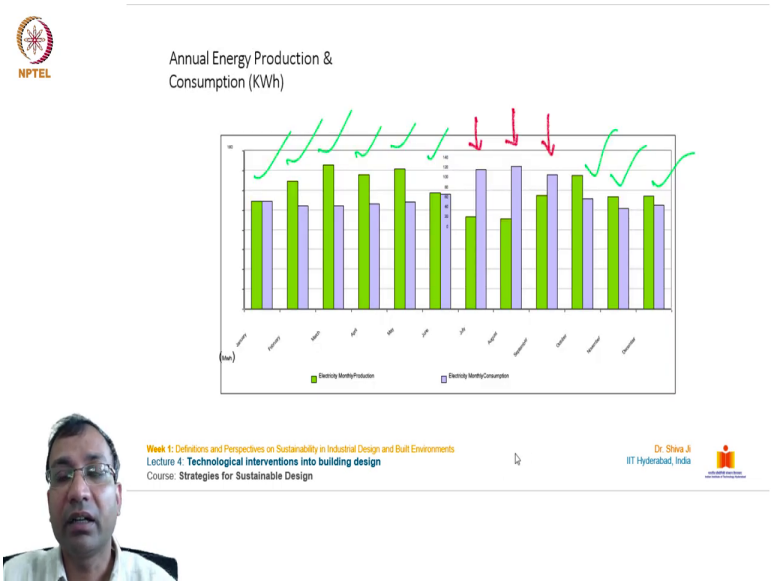

And like, energy, like, production and consumption. So, this is a comparison, like how this building has performed in which month. So, the only 3 months where the consumption has exceeded the energy actually, production, you see this green bar to this placed to this purple bar. So, the purple bar depicts the consumption and this green one depicts the energy generation.

So, the energy generation, relatively is lower in these months. So, these are actually July, August, September, these are cloudy months when there is like, a over sky and mostly like rainy days so the power generation has gone down and rather, like, dehumidification is also needed in these months. These are months specifically for running air conditioners, so the power consumption has relative gone up. Rest of the months, you can see, the power generation is always above the consumption of electricity in this building.

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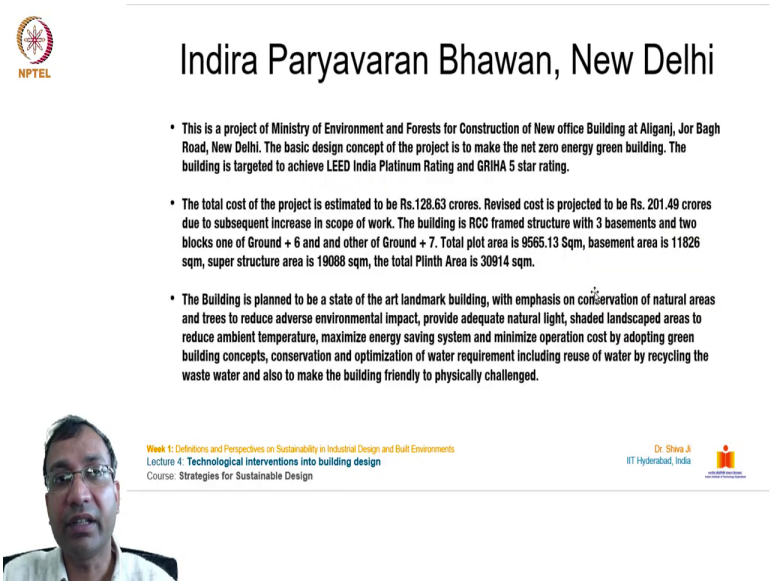

So, I would like to give you some facts about this building. So, the Indira Paryavaran Bhawan, New Delhi, this is a project off the Ministry of Environment and Forest for construction of new office building at Aliganj, Jor Bagh Road New Delhi. The basic design concept of this project is to make the net zero energy green building. The building is targeted achieve LEED India Platinum Rating and GRIHA 5 star rating.

The total cost of the project is estimated to be 128.63 crores, Indian National Rupees. Revised cost is projected to be 201.49 crores. Due to subsequent increase in the scope of work, the building in RCC frame structure with three basements and 2 blocks, 1 of ground plus 6 and another of ground plus 7. Total plot area is 9,565.13 square meters. Basement are area is 11,826 square meters. Super structure are is 19,088 square meters and total Plinth area is 30,914 square meters.

The building is planned to be a state-of-the-art landmark building with the emphasis on conservation of natural areas and trees to reduce adverse environmental impacts. Provide adequate natural light, shaded landscape areas to reduce ambient temperature, maximize energy saving systems and minimize operations costs by adopting green building concepts. Conversation and optimization of water requirement including reuse of water by recycling the wastewater and also to make the building friendly, to like physically challenged persons.

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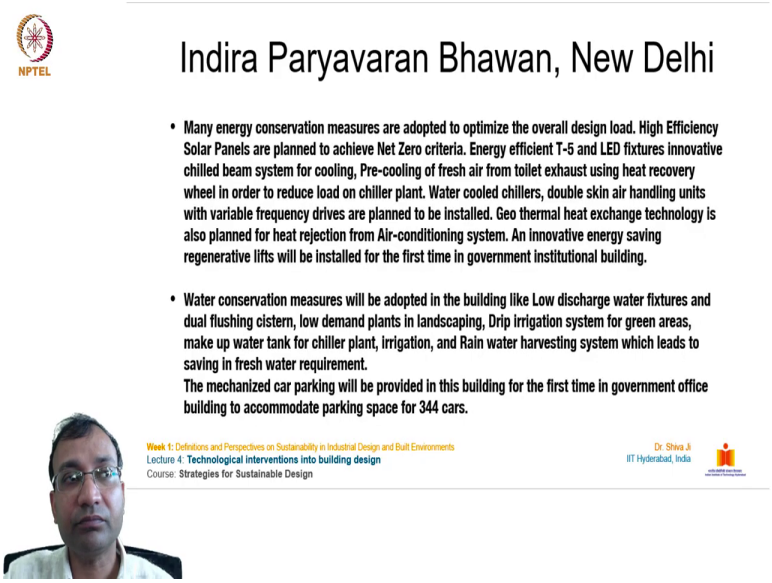

Many energy conservation measures are adopted to optimize the overall design load. High efficiency solar panels are planted to achieve net-zero criteria. Energy efficient T-5 and LED fixtures innovative chilled beam system for cooling, pre-cooling of fresh air from toilet exhaust using heat recovery wheel in order to reduce load on chiller plant.

Water cooled chillers, double skin air handling units with various, variable frequency drivers are planned to be installed. Geothermal heat exchange technology also planned for heat rejection from air conditioning system. And innovative energy saving regenerative lifts will be installed for the first time in governmental institutional building.

Water conservation measure will be adopted in the building, like low discharge water fixtures and dual fishing, flushing systems, low demand plants in landscaping, drip irrigation system for green areas, make up water tanks for chiller plants, irrigation and rainwater harvesting system which leads to saving in fresh water requirements. The mechanized car parking will be provided in this building for the first time in governmental office building to accommodate parking space for 344 cars.

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On the net-zero design factor, well, this IPV building reduces energy requirement by 67 percent overall vis-à-vis like a conventional method. N-S North-South orientation, limiting WWR, insulation on wall and roof, extensive greenery to reduce heat load, maximizing day lighting to reduce lighting load, extremely low lighting power density, 5 watts per square meter.

Planning to minimize AC loads keeping open atrium for cross ventilation, non-air-conditioned lobbies. Efficient HVAC with Screw Chillers, VFD's, Chilled Beams Ground based heat exchange for condenser, water remote computing thin client servers. Energy efficient appliances like, all 5-star BEE rated appliances are used and solar photovoltaic cells panels for remaining load.

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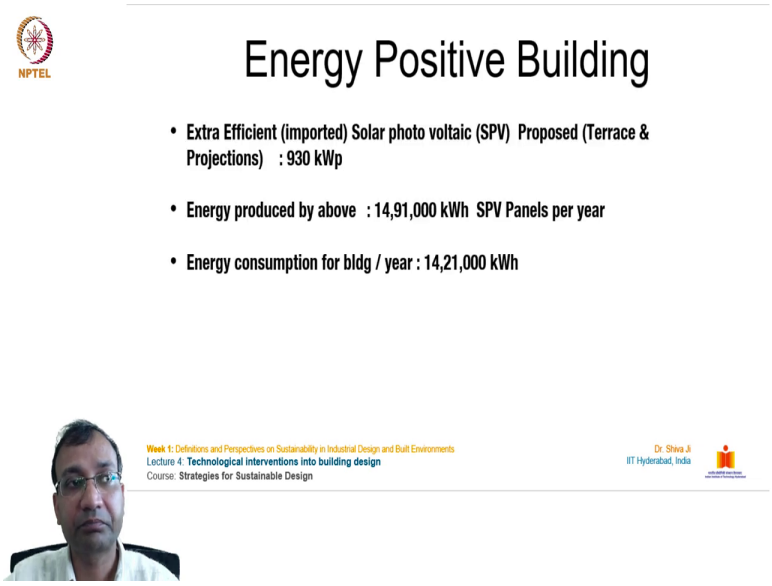

This is an energy positive building. Extra efficient imported solar photovoltaic, SPVs, proposed terrace and projections, 930 kilo watts. Energy produced by above is like, in this range, like per year, energy consumption for building per year. Like, it is in this range. So, you see the consumption has increased little bit, it is always under the energy produces. So, the overall, I think this building falls under net-zero energy, surplus project.

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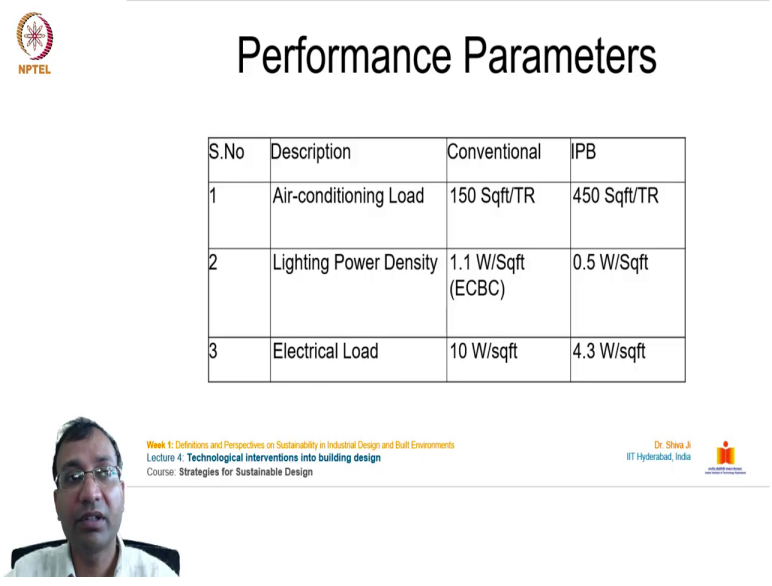

So, performance parameters if you see, Air-conditioned load is this much. Lighting powder, power density load is here, electrical load is given over here.

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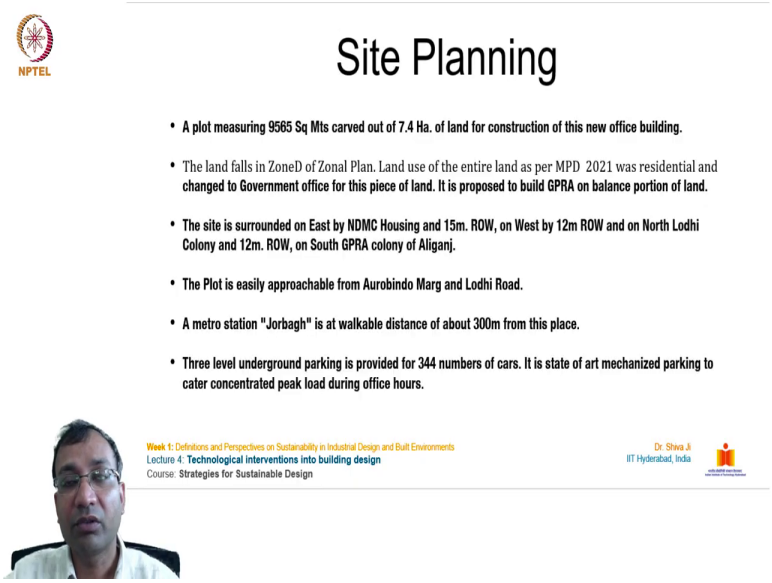

So, let us talk about something about like, site planning. A plot measuring like 9,565 square meters coveted out of like, 7.4 hectares of land for construction of this new office building. The land falls is Zone D of Zonal Plan. The land use of entire land as per MPD 2021 was residential and changed to Government Office for this piece of land. It is proposed to build GPRA on balanced portion of the land.

It is, the site is surround on East by NDMC housing and 15 meter ROW on West by 12 meter ROW and on the North, Lodhi Colony and 12 meter ROW on South GPRA Colony of Aliganj. The plot is easily approachable from Aurobindo Marg and Lodhi Road. The metro station Jorbagh is at walkable distance of about 300 meters from this place.

Three level underground parking is provided for 344 number of cars. It is state of art mechanized parking to cater central, concentrated peak load during the office hours.

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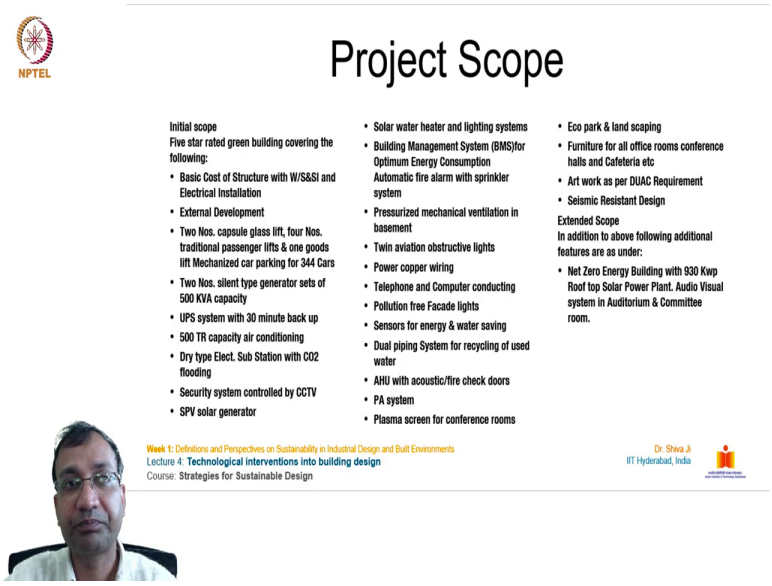

In, in the project scope, if you see, it has initial scope and extended scope. It is like 5-Star rated Green Building covering the following basic cost of structure with like, this electrical insulation, external development, two number of capsule glass lifts, four number traditional passenger lifts, one goods lift, mechanized car parking for 344 cars, et cetera. So, that, this data you can refer over here, what it has catered.

In the extended scope in addition of the above, the following. This net-zero energy building in 930 kilo watts, this rooftop solar power plant, audio-visual system in auditorium and committee rooms. So, these are the features of, which are under the scope of this project.

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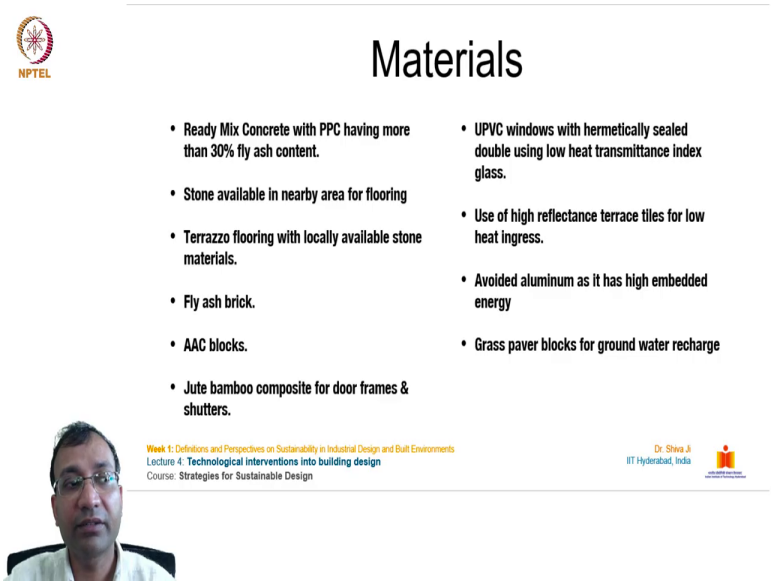

On, the material front, ready mix concrete with the PPC having more than 30 percent fly ash content. Stone available in the nearby area for like, flowing is used. Terazzo flooring with locally available stone materials. Fly ash bricks. AAC blocks. Jute bamboo composite for door frames and shutters.

UPVC windows with hermetically, like a sealed double using low heat transmittance index glass, double glaze glass. Use of high reflectance terrace tiles for low heat ingress. Avoid aluminum as it has high embedded energy. Grass paver blocks for ground water recharge.

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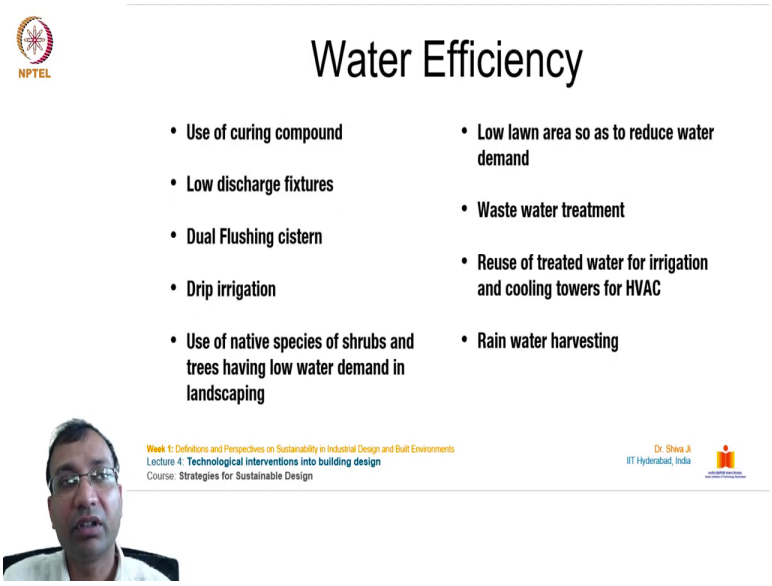

For the water efficiency, use of curing compound. Low discharge fixtures, Dual flushing cistern, Drip Irrigation. Use of native species of shrubs and trees having low water demand in landscaping. Low lawn area so as to reduce water demand. Wastewater treatment. Reuse of treated water for irrigation and cooling towers of HVAC. Rainwater Harvesting.

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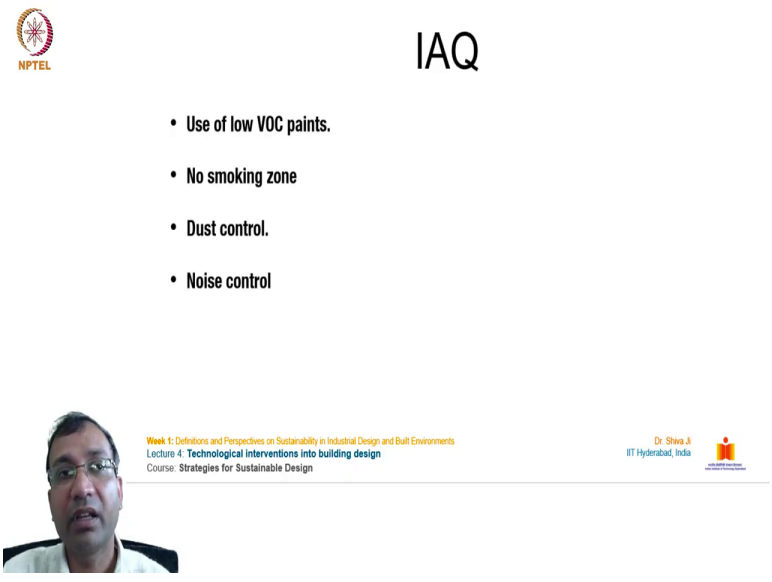

In the Internal Air, Indoor Air Quality, use of low VOC paints. No smoking zone. Dust control. Noise control is used.

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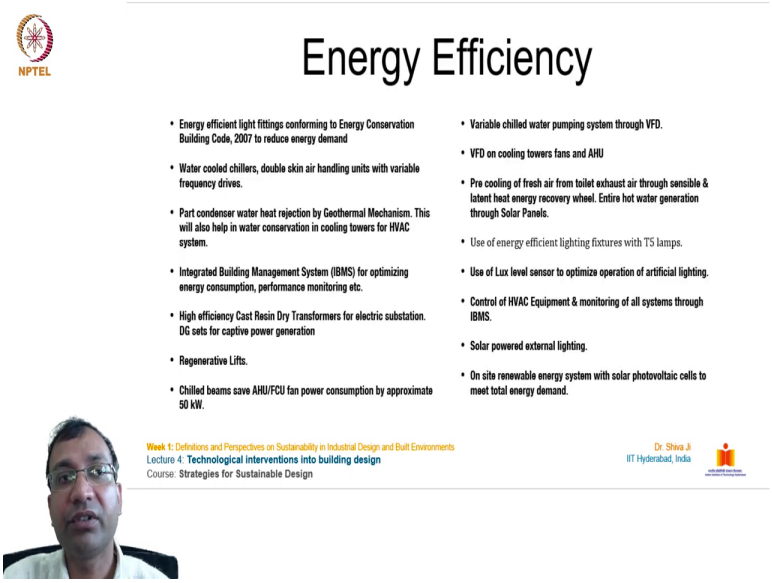

On the energy efficiency front, energy efficient lighting fittings are used which comply to the NBC code. Water cooled chillers; double skin air handling units are also used. So, you see, the details over here. This we have discussed in the previous slides also.

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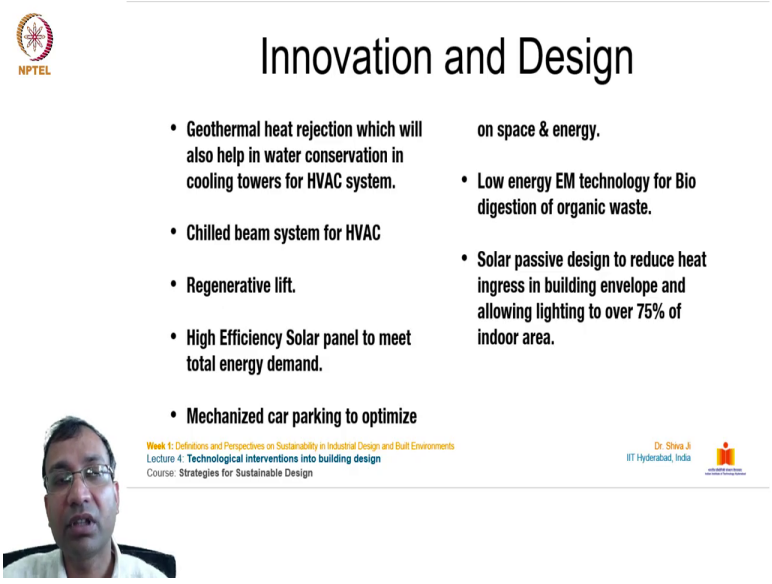

Innovative, innovation and design. So, geothermal heat rejection, which will also help in water conservation in the cooling towers for HVAC system is used in this site. Chilled beam system for HVAC. Regenerative lift. High efficiency solar panel to meet total energy demand. Mechanized car parking to optimize space and energy. Low energy EM

technology for bio-digestion of organic waste. Solar passive design to reduce heat ingress in building envelope and allowing lighting to over 75 percent of the indoor area.

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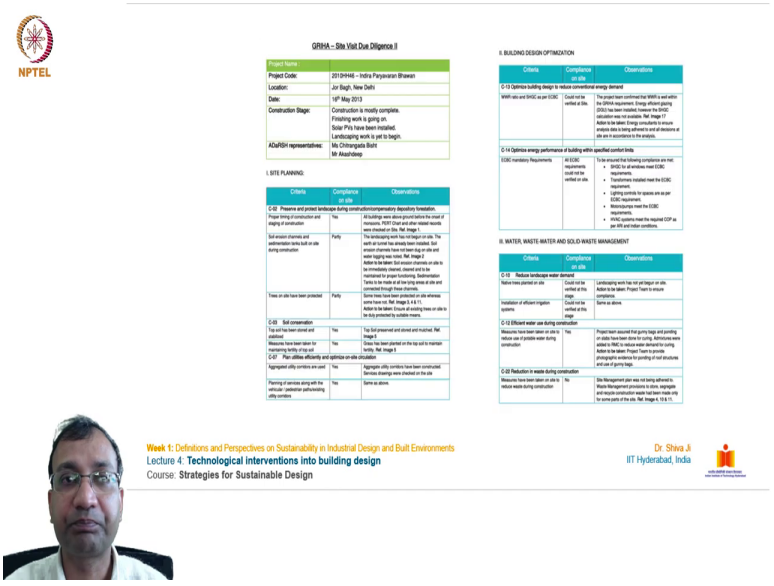

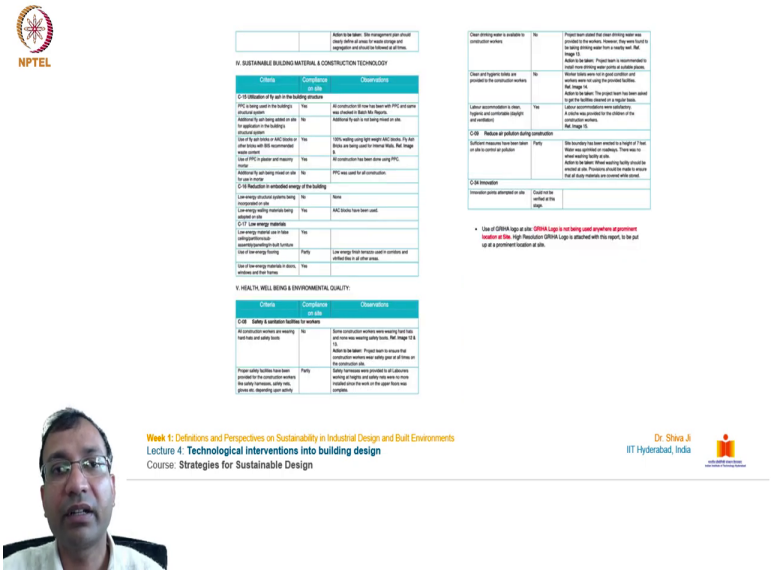

This is actually this GRIHA site visitor due diligence 2 report. You can see over here, this is, I have accessed from the website of this Indian Paryavaran Bhawan. It was available 2 years ago. So, maybe you can refer this document for the detail observation and report from a GRIHA which was conducted on this building.

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Week 1: Definitions and Perspectives on Sustainability in Industrial Design and Built Environments
Lecture 4: **Technological interventions into building design**
Course: **Strategies for Sustainable Design**

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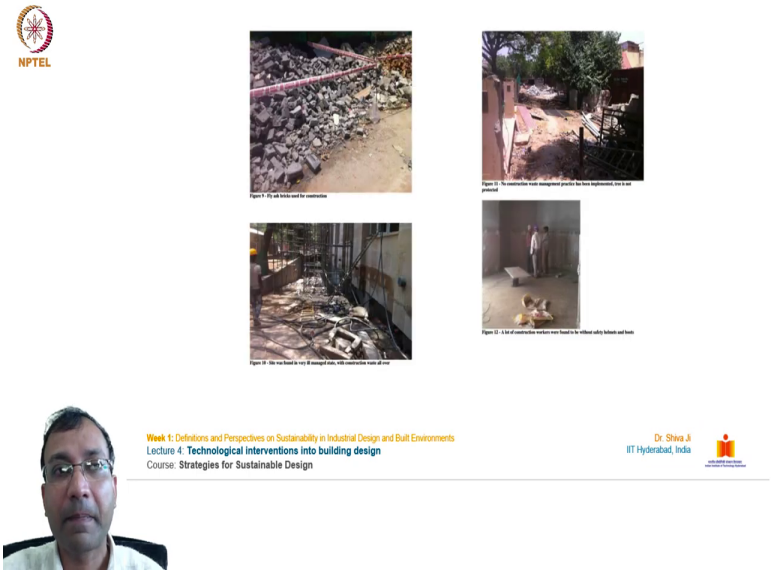

So, these images are a part of this report. Like, how they have observed the various activities on the site and they have reported. So, with this, we have come to the end of this lecture. Thank you, everyone.