Green Sprout School

Project Data

Location :	Tehran, Iran
Climate Zone:	3B, Bsk
Lot Size :	0.68 acres
Building Size :	2992 m^2
Occupancy :	About 150 people
Occupancy details:	120 Students, 30 teachers and staffs (19.94 m^2/person)
Target Source EUI :	-11.30 kWh/m^2.year
Cost Estimate :	283.37 \$/m^2

Project Summary

In recent years, global concerns over energy consumption reduction and carbon emissions have extended to
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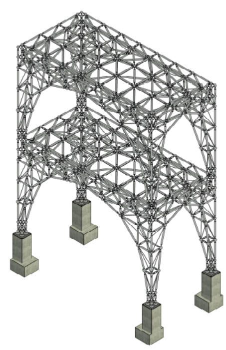
Iran. As part of the green building initiative, priority is given to repurposing pre-existing abandoned sites that have the potential to cause social issues in their surrounding environment. The team has chosen a long-abandoned site in District 12 of Municipality for the design project. The site is divided into a dilapidated section and a commercial section, with the abandonment causing social problems in the commercial area and neighboring region. The site's proximity to a park further exacerbates the social issues. To address these problems, the team has opted for an educational design approach, which would have a positive impact on the social environment. The aim to revitalize the damaged fabric by redesigning the commercial section and constructing a new educational building on the site would be a significant step towards sustainable and resilient design.

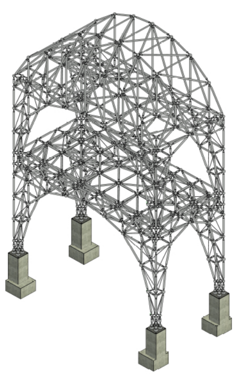
Design Strategy

Considering the social and cultural conditions at both the site and national levels, the team aimed to create an architectural form that not only connects strongly with its surroundings and revitalizes the damaged fabric but also pays homage to ancient Iranian architecture. The primary goal was to integrate authentic architectural concepts with sustainability and resilience in construction. In line with this vision, the choice of construction methods and materials became crucial. Given the presence of a nearby second-hand steel sales location, the team adopted a modular construction approach using second-hand scaffold pipes. This strategy allowed for flexibility in form and a parametric construction pattern that could be executed by both students and non-experts, fostering a social connection with the environment through temporary spaces at minimal cost and time. these temporary spaces may serve as shelters during crises with the assistance of individuals themselves. To achieve near-zero energy consumption while ensuring occupant thermal comfort, the team combines Water and Air based GHX with solar systems in the form of BIPVT and PV panels. The design also presents an opportunity for income generation through temporary exhibition spaces and the sale of excess energy and water to neighboring individuals. Ultimately, this approach fosters a harmonious relationship between the environment, humans, and the construction site, leading to fabric revitalization and reductions in carbon emissions and energy consumption.

Second-Hand Steel Space Frame Modules



-Type 1: Flat Level Surface



-Type 2: Vaulted Roof

Technical Specifications

R-Values

Existing
- External wall : 3.64 m^2.K/W
- External roof : 4.50 m^2.K/W

Target& new building
- External wall : 4.79 m^2.K/W
- External Flat roof : 4.55 m^2.K/W
- External Vaulted Roof: 4.65 m^2.K/W

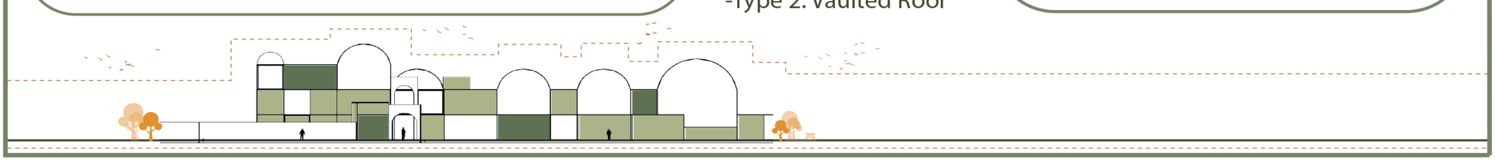
HVAC

Existing: Local Conventional System Powered By:
-Cooling: Evaporative Cooler
-Heating: Electrical Heater
-DHW: Stand Alone Water Heater

Target and New Buildings:
Air Handing Unit (AHU) With Heat Recovery and Free Cooling Powered By:
-Cooling: Air Cooled Chiller & Air Ground Heat Exchanger & BIPVT
-Heating: Gas Fired Boiler & BIPVT
-DHW: Gas Fired Boiler and Water Tank Storage & Water Ground Heat Exchanger & BIPVT

On-Site Renewable

On-Site Renewable Systems:
24.5 kW BIPVT South Vault Modular Façade, and 47.5 kW PV
50 m Air Ground Heat Exchanger Pipes
50 m Water Ground Heat Exchanger Pipes



Project Highlights

Architecture

The design team aimed to revive past Iranian architecture by designing a school in the disadvantaged Shush neighborhood of Tehran. we utilized vaulted forms, chahartaq forms, central courtyard elements, and modular design, to create the architectural concept. The project involved redesigning existing buildings and constructing new ones. The redesigned buildings focused on revitalizing commercial spaces and offering educational workshops. The new school buildings were influenced by Iranian geometry, easily fitting into the site's irregular layout, and blending traditional architecture with modern engineering. Ultimately, the school became a neighborhood center that enhanced the cultural, social, economic, and energy aspects of the area.

Engineering

The first concern of the team was to choose a structural system that contains minimum embodied carbon with sufficient stability. Then a modular second-hand scaffold pipe was selected as the structural system to increase the speed of construction, lower construction costs, and reduce embodied carbon. Additionally, due to the modular nature of the structure, the Green Sprout School will have the possibility of expansion and growth in the future. On the other hand, the suggested structural system will help to easily install the air ducts, and pipes through the floor of the spaces. using a creative hybrid system, including PV, BIPVT, Water-Based GHX, and Air-Based GHX, to guarantee its durability in times of crisis in addition to reducing energy consumption.

Envelope

The design team implemented different solutions for envelope design based on the two objectives of redesign and new building design. Existing buildings were retrofitted by preserving the main structures and using mycelium wheat for thermal insulation and algae tiles as finishing materials. In new buildings, mycelium was also used for thermal insulation, while algae were used for finishing. To provide insulation and a vapor barrier for the exterior envelope of the building, a layer of polyethylene was used on the outer surface as an air and vapor barrier layer. Additionally, to break the thermal bridge, all metal connections between the structure and the interior surface of the building were controlled with rubber and suitable thermal insulation.

Efficiency

The design team aims to use renewable energies in the form of active and passive systems, as well as water treatment, to reduce energy and carbon emissions, increase building resilience, improve economic conditions, and decrease water consumption. The total source EUI of the building is calculated to be -11.30. Through rainwater collection, gray water recovery, and desalinated water gathering, the annual water collected exceeds the need by about 200 m^3.

Grid-Interactivity

With the aim of designing a school as a neighborhood center, the school building has the ability to allocate thermal and electrical energy, as well as transfer purified water to its surrounding fabric. In this regard, through careful and logical design and the use of tools such as motorized valves, water storage tanks, water purification devices, charge control devices, and backup batteries, the school building will be able to easily exchange energy and water with its surroundings. According to the design, the school building can annually allocate 200m3 of purified water, 36 MWh of thermal energy, and 51 MWh of electrical energy to its surrounding network. Additionally, the building can receive annually 80 MWh and 22 MWh of thermal and electrical energy, respectively, from the national energy grid to meet its own needs.

Life-Cycle

By preserving the main body of the existing building, using second-hand scaffold pipes, mycelium wheat, and algae tiles, we try to reduce carbon and enhance the circularity. To reduce the operation carbon emissions, the precise and optimal design of passive and active systems was put on the agenda. Finally, the embodied carbon benchmark for new and retrofit buildings are calculated at 294 kg Co2e/m2 and 195 kg Co2e/m2 respectively.

Health

By choosing second-hand scaffold pipes, the building is ensured to be very durable. The distribution of sufficient fresh air in the interior spaces ensures the health of the occupants during times of crisis, such as a pandemic. Proper sound and light zoning, the use of sound-insulating materials, and lighting sensors, along with various construction details, will help control daylight and external noise. Additionally, the use of flexible furniture for different educational methods would improve students' teamwork abilities.

Market

To achieve economic resilience for the school building and improve the economic conditions of the school's surrounding area, the design team will revitalize the surrounding fabric in terms of traffic and security, while maintaining the commercial aspects. Additionally, by obtaining permission from commercial units offering lower rental costs, they will improve the business conditions for the residents. Furthermore, enabling the sale of students' art craft products and issuing bank cards for teenagers, along with creating income opportunities for students, will prepare them for future social endeavors. When considering all economic factors, the economic calculations of the school were made under risky conditions, and the results indicate that the PBT index will reach 100% in less than 12 years.

Community

The selected site includes special conditions in terms of social context. Due to being abandoned for a long time, the site has become a place for social criminals and has no proper social fabric on a local scale. Now, with the redesign of the site, the surrounding urban fabric will be revitalized and uplift the social condition of the people. To strengthen the relationship between the neighbors and the school several actions are taken, such as designing a bicycle, holding temporary exhibitions, and providing a study and gathering space for the community.