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THE SINGAPORE ENGINEER

COVER STORY:

SUSTAINABILITY

NTU Sports Hall

FEATURES:

Transportation Engineering • Chemical & Petrochemical Engineering • Focus on Singapore

NTU Sports Hall

To be ready in 2016, the new recreation facility has already clinched the Green Mark Platinum Award at BCA AWARDS 2015.

The new NTU Sports Hall won the Green Mark Platinum Award at BCA AWARDS 2015.

Nanyang Technological University (NTU) is a global leader in sustainability research, attracting more than S$ 1.2 billion in research funding, whilst also putting into practice the principles of sustainability, in the design of its lush, green campus.

The new Sports Hall is designed with sustainable features, in line with NTU's intention to achieve a 35% reduction in energy and water consumption as well as waste production, by 2020, under its EcoCampus initiative.

With an area of 10,000 m^2, the three-storey Sports Hall will be able to accommodate 1,000 spectators, effectively doubling the current seating capacity. The mechanised seats will be retractable, so that the venue could be configured into 13 full-sized badminton courts or into three basketball / volleyball courts and a netball court.

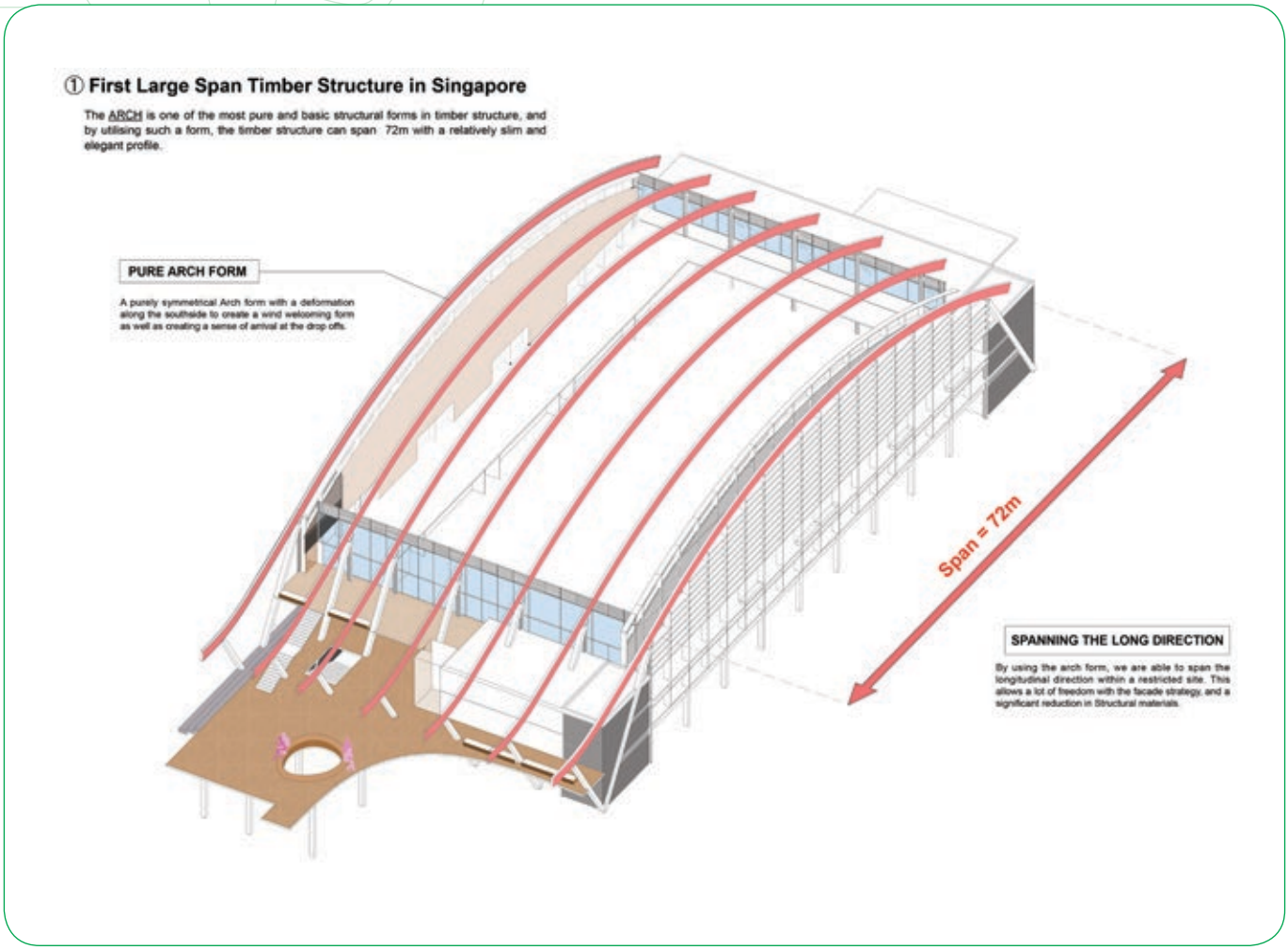
KEY SUSTAINABILITY FEATURES

In order to achieve sustainability, the project has adopted, right from the start of the design, a range of measures including the use of environment-friendly materials as well as energy efficiency and water efficiency features.

ENGINEERED WOOD SYSTEM

The Sports Hall will be the first large-scale building in Singapore to employ an engineered wood system (EWS) in a newly adopted design and construction process. The building will be constructed using combined structural systems. The superstructure will be an EWS that sits on a normal reinforced concrete substructure. Two forms of EWS will be used for the Sports Hall. Glulam (glued laminated timber with panels linearly aligned) will be used for beams, columns and the long span roof support, and prefabricated CLT (cross-laminated timber) will be used for internal finishes and flooring.

An EWS is created through binding layers of timber using structural adhesives to produce solid plane timber suitable for roofs, floors or walls. The durability of the Sports Hall superstructure is optimised through a combination of measures including provision of a sacrificial



The long-span glulam roof structure provides heat insulation, thereby contributing to reduced energy consumption.

layer and protection cappings to ensure water-tightness for the purpose of weather-proofing and, through design, prevention of water stagnation to preserve the viability of the CLT structure. The adoption of the unique long-span glulam roof structure provides greater heat insulation than concrete, which contributes to reduced energy consumption.

One of the best-performing building materials from a sustainability perspective, EWS is produced from sustainably-managed forests, possesses the least carbon footprint among building materials, reduces overall cooling costs during its lifecycle and it can be recycled upon demolition. The use of such materials has grown exponentially right across Europe over the last two decades, for projects that range from residential premises to commercial spaces and from private establishments to public buildings. European construction has recorded reductions in on-site labour, programme duration, the need to deliver materials to work sites and inconveniences to neighbours. The lighter construction of an EWS, as compared to concrete, has also reduced the need for heavy foundations.

The use of EWS in Singapore offers benefits through its whole lifecycle, including the potential for less on-site manpower; a reduction in construction-related noise and pollution; a safer working environment; shorter site construction periods; and an improved sustainability standard. The EWS panels will be imported from overseas suppliers and a design review between the consultant and main contractor will be finalised, prior to installation. Skilled installers will complete the installation of the panels and a range of monitoring, control and inspection procedures will be put in place to monitor each phase of installation.

OTHER MATERIALS

The Sports Hall makes extensive use of other environment-friendly materials, besides EWS. For example, carpets, dry walls and ceiling board materials with a high recycled content will be used. Only adhesives with low volatile organic compound (VOC) content and low VOC paints will be used for the interior finishes.

NATURAL VENTILATION

Through modelling and analysing sun and wind patterns on site, the Sports Hall design takes full advantage of

its natural surrounds. This results in optimising the use of natural ventilation, reducing the need for mechanical ventilation, leading to a reduction in energy consumption.

AIR-CONDITIONING DESIGN

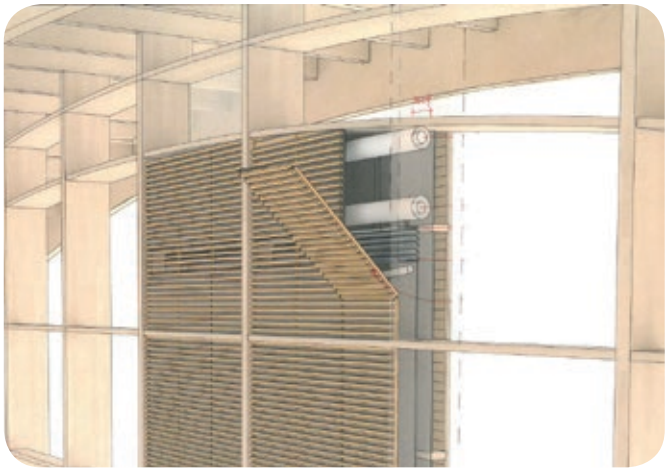
While the need for air-conditioning can be reduced in Singapore, it cannot be eliminated and as such, an energy-efficient air-conditioning system has been designed. This incorporates a passive induction cooling system for the Sports Hall, water cooled chillers with cooling towers, two 220 RT (refrigeration tons) chillers with R134a refrigerant as well as chilled water and condenser water pumps with variable speed drives.

Passive induction air-conditioning

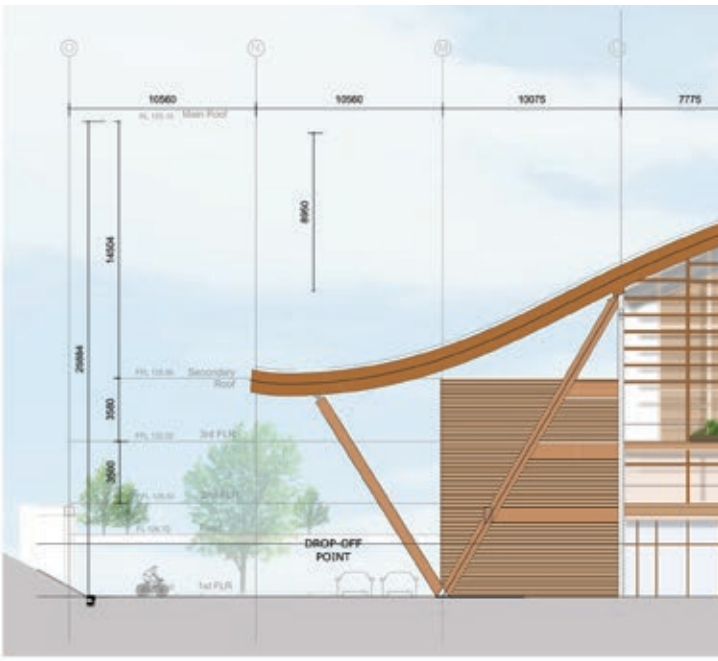
Working on the basic principle that hot air rises and cold air sinks, the passive induction air-conditioning system supplies cooled air at floor level, which is warmed up by the heat from the building and the occupants. It then becomes buoyant and floats up towards the ceiling where chilled water coils, at a high level, cool the warm air.

This system for the Sports Hall, derives energy savings from two main features. Firstly, the temperature in the 12 m-high space will be stratified, such that only the occupied zone will be cooled. The upper zone, which is void space, does not need to be cooled. This is unlike the conventional air-conditioning system where cooled air is mechanically forced down from the ceiling and the entire volume is cooled. Secondly, the need for a fan to distribute the air is eliminated as the convective force is provided by the heat load in the space.

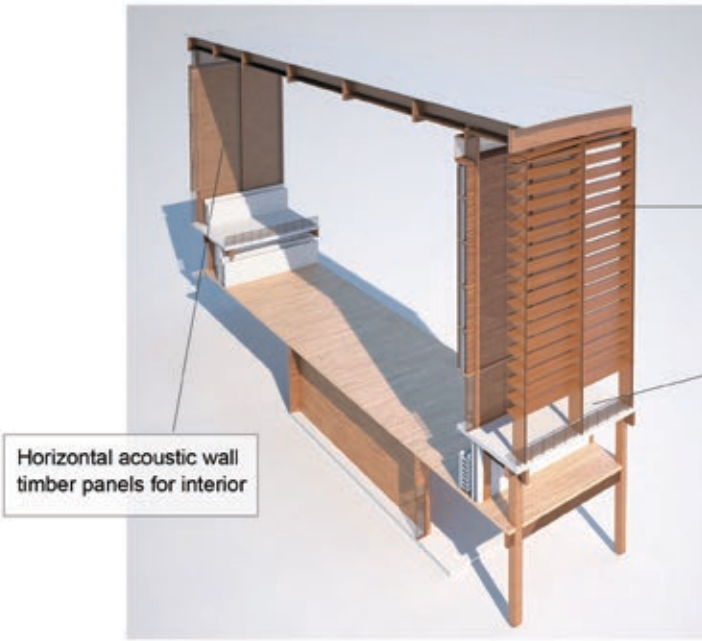
This passive induction air-conditioning system has many benefits. It sets a new benchmark for providing thermal comfort, saving energy and reducing the need for frequent maintenance. It also eliminates the need for unsightly metal ducting hanging from the ceiling to distribute cooled air, which also saves space. From a maintenance perspective, this system eliminates the need for cleaning and maintenance of the ducts and air

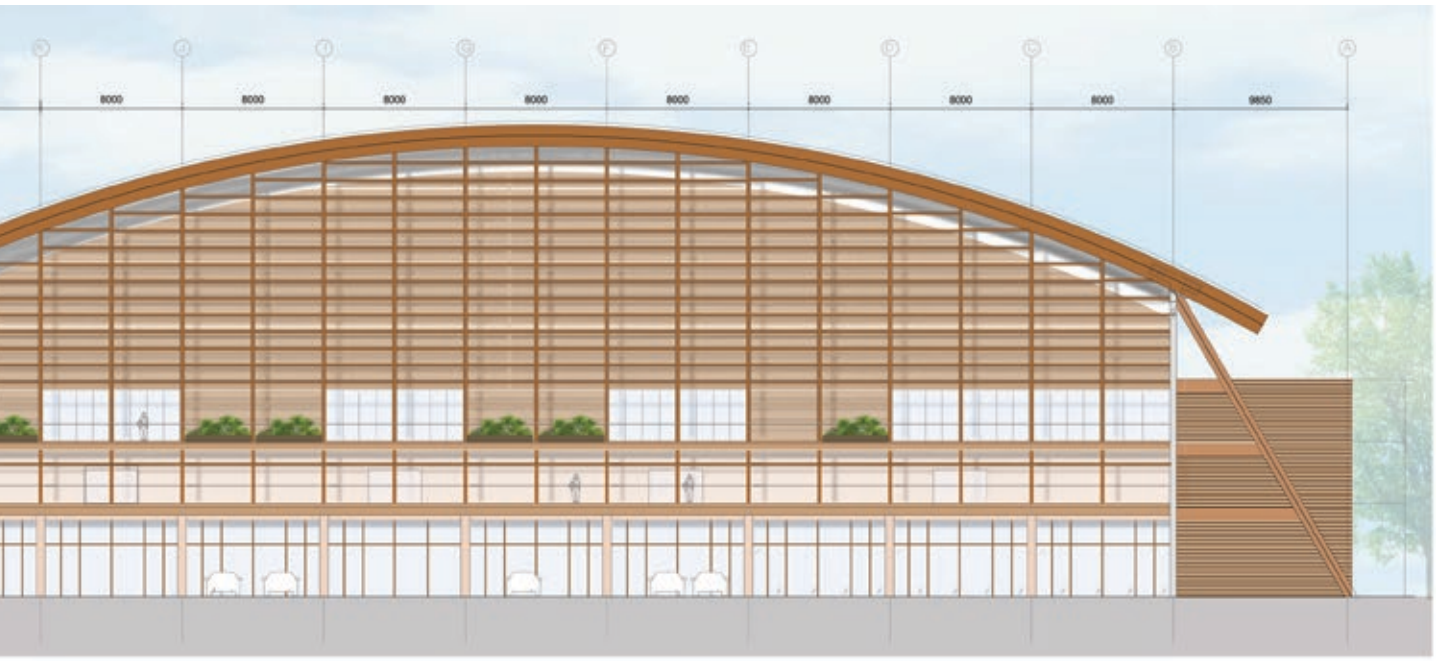


Chilled water coils, at a high level, cool the warm air.

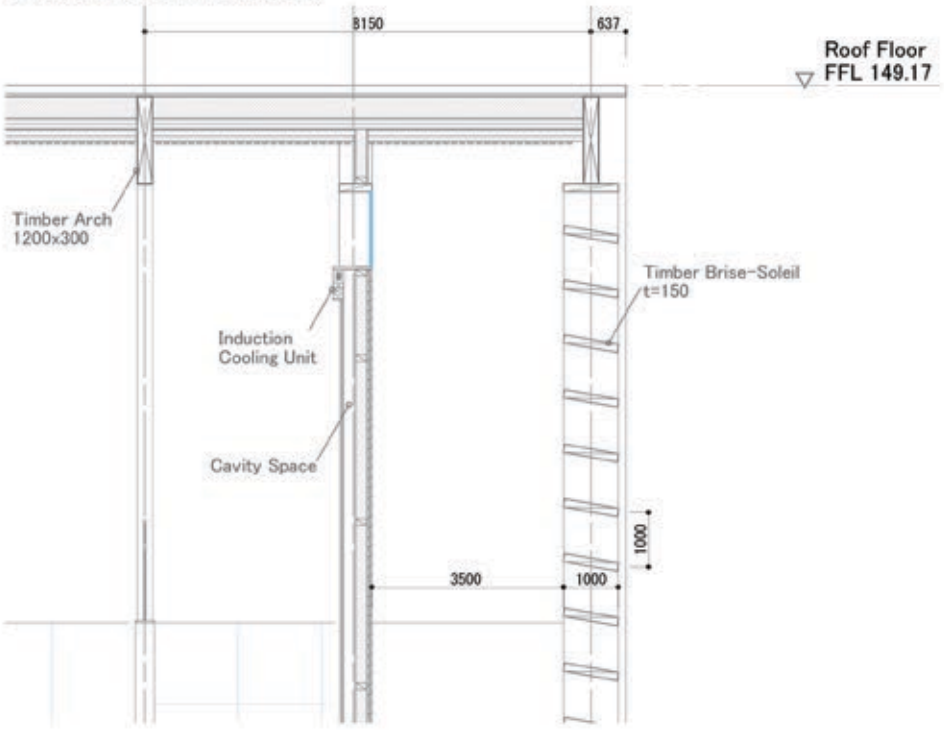


EAST FACADE - ENGAWA (PARTIALLY OUTDOOR SPACE)





DETAIL SECTION 1:100 (A3)



WOOD GRID LOUVERS

To cut off driving rain, and a percentage of sunlight within the engawa space

ENGAWA SPACE

Can be used freely as a relaxing green space, as well as being able to visually connect with the sports hall (Can act as viewing platform during matches)

The east elevation

diffusers associated with a conventional air-conditioning system. For the users of the Sports Hall, in particular, badminton players, the potential for condensation and draughts, associated with a conventional air-conditioning system, is eliminated, providing thermal comfort and the optimal environment for sporting activities.

Chiller efficiency

An auto condenser-tube-cleaning system is incorporated into the chillers. This system automatically cleans the condenser water tubes daily to prevent scaling and fouling. It reduces the frequency for regular tube cleaning and allows the chillers to maintain good heat transfer with regular cleaning of the condenser tubes.

Further, provision has been made for chiller plant efficiency monitoring. The permanent measuring instrumentation will include full bore, magnetic, multiple point type flow meters or equivalent, temperature sensors with accuracy of +/-0.05° C, provision of two spare thermo wells at both sides of the temperature sensor, and power meters with +/- 1% accuracy.

LIGHTING DESIGN

Maximising natural light

The design of the Sports Hall seeks to optimise the use of natural daylight and reduce the artificial light requirements. Common areas are designed to receive adequate daylight and have daylight sensors installed to eliminate unnecessary daytime use of artificial light. The east and west walls of the sports hall are protected from the environment and incorporate a continuous top light shelf (halo) that brings diffused light into the sports hall. As a result of these measures, the energy consumption associated with artificial lighting is reduced.

Artificial lighting

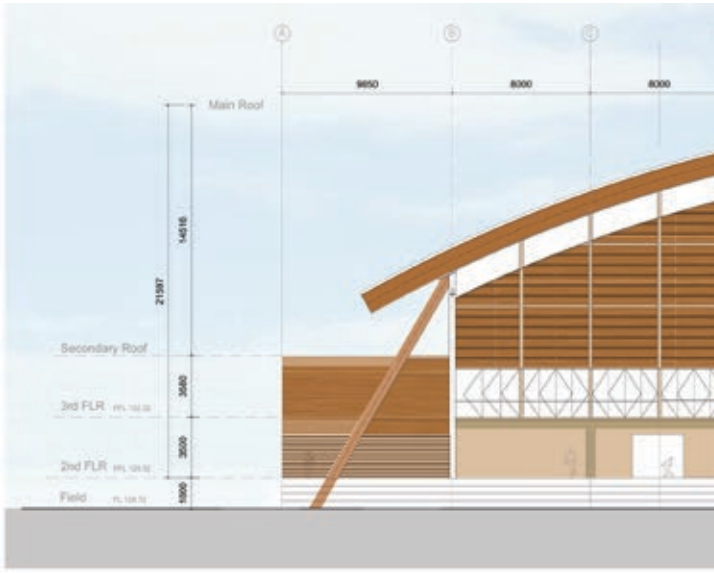
The use of energy-efficient light fittings and a lighting control system will keep lighting usage flexible. LED lamps are used to reduce the operating wattage. The zoning of the activity and gallery areas will allow for variable lighting to be used to suit user needs, and motion sensors will be installed in areas of low usage such as the toilets and staircase areas.

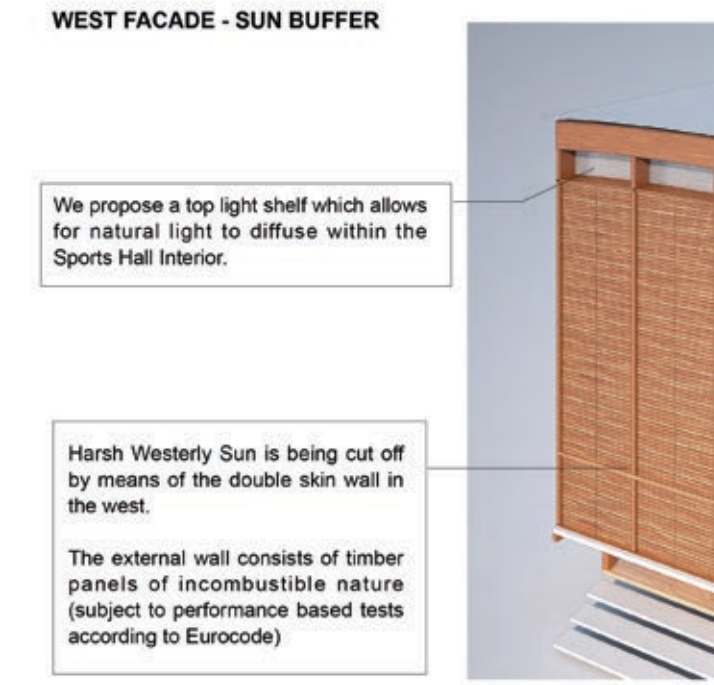
ENERGY-CONSERVING LIFT

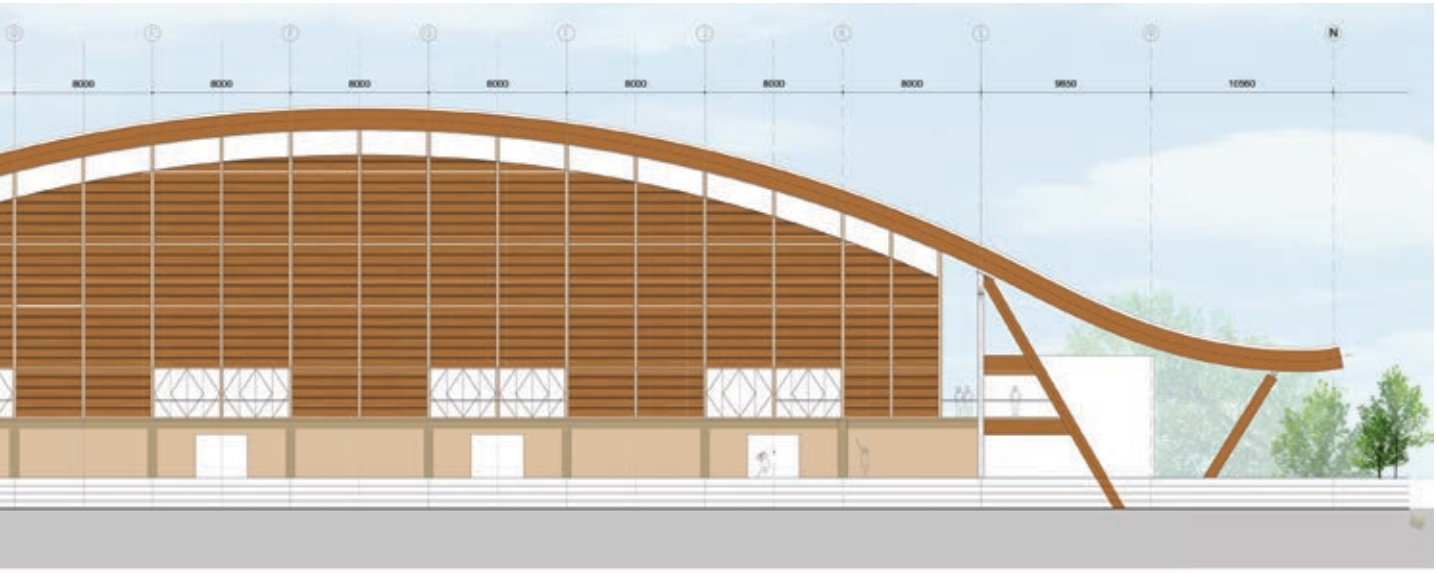
Energy conserving features such as an AC variable voltage variable frequency motor drive and the sleep mode will be incorporated into the lift that will be installed at the Sports Hall.

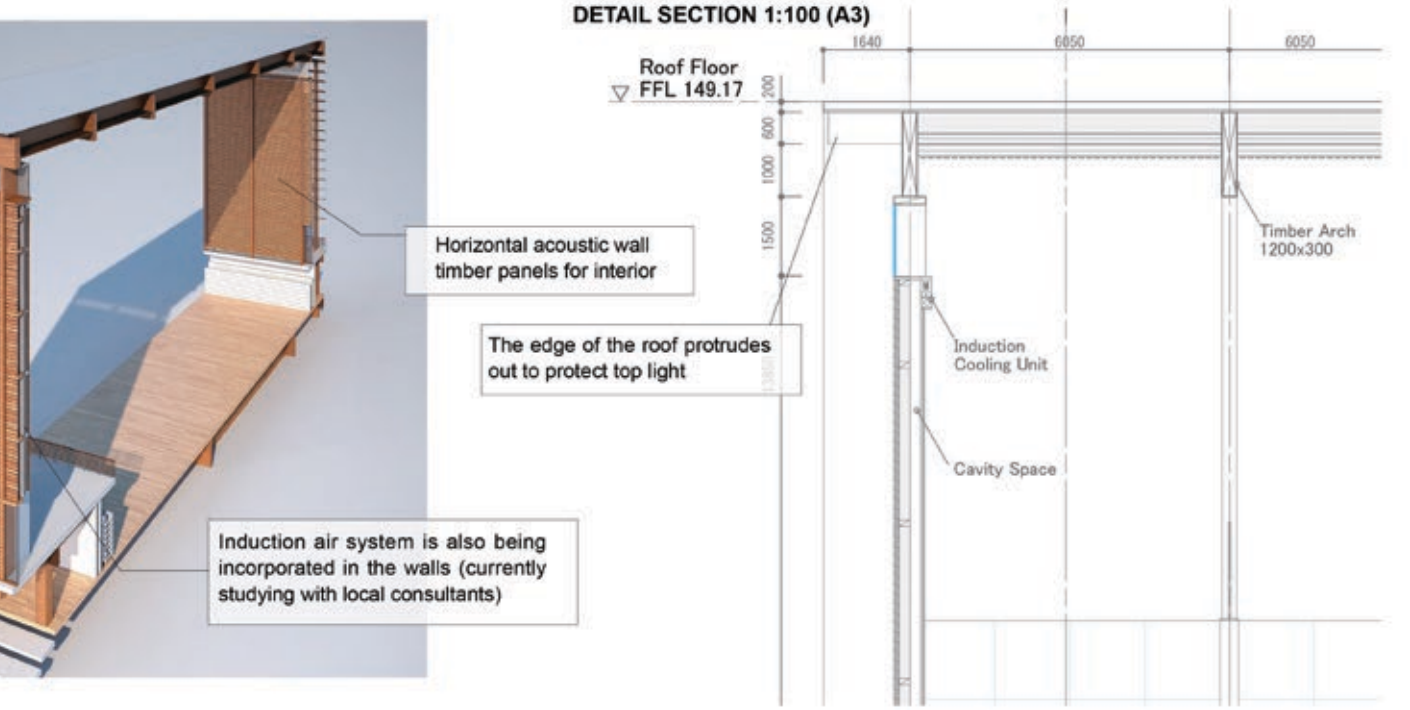
WATER CONSERVATION

Efficient low-flow water fittings will be used extensively. Since significant amounts of water will be used in the cooling tower system, water sub-meters will be installed for the cooling towers and linked to the BMS and water





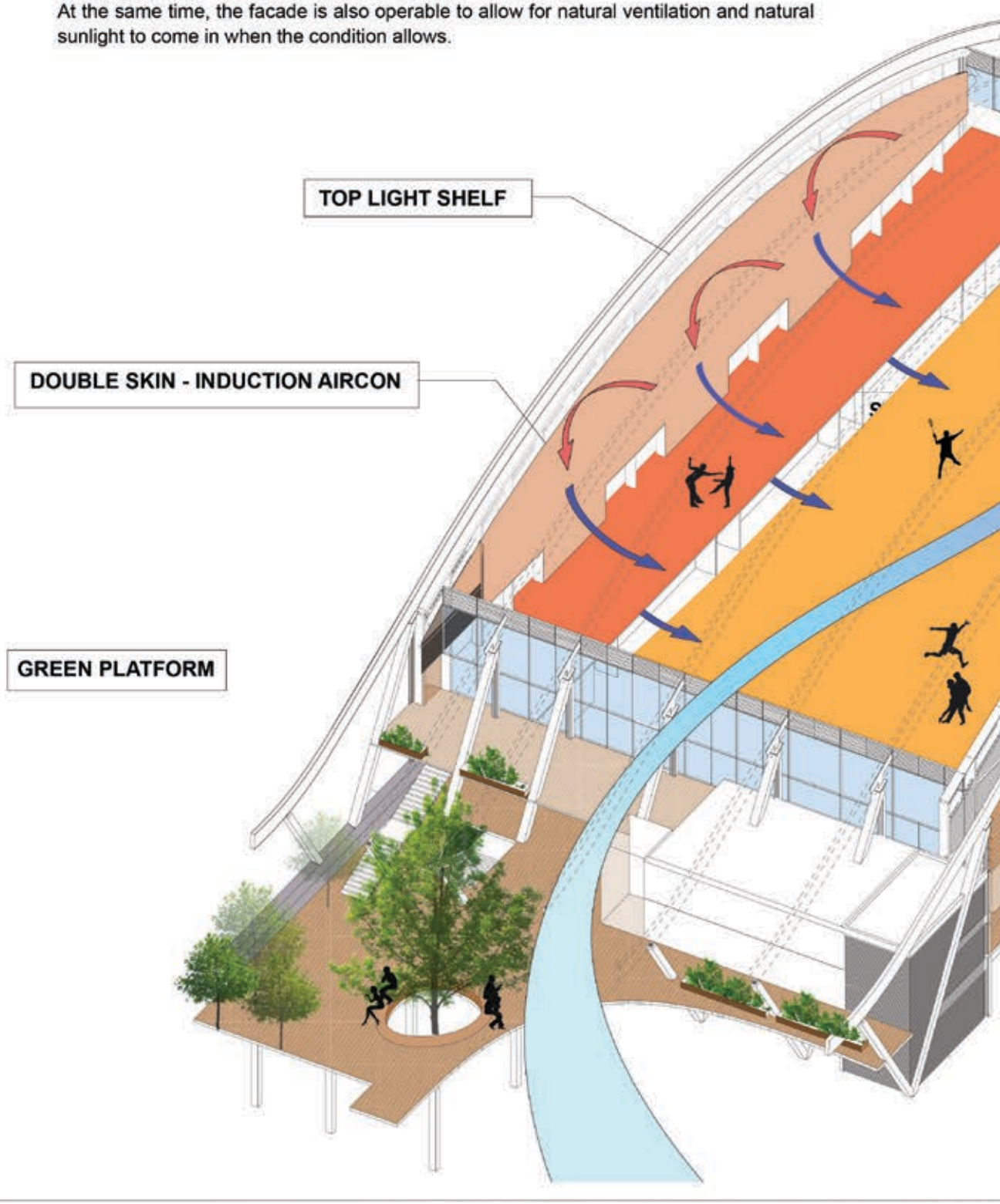


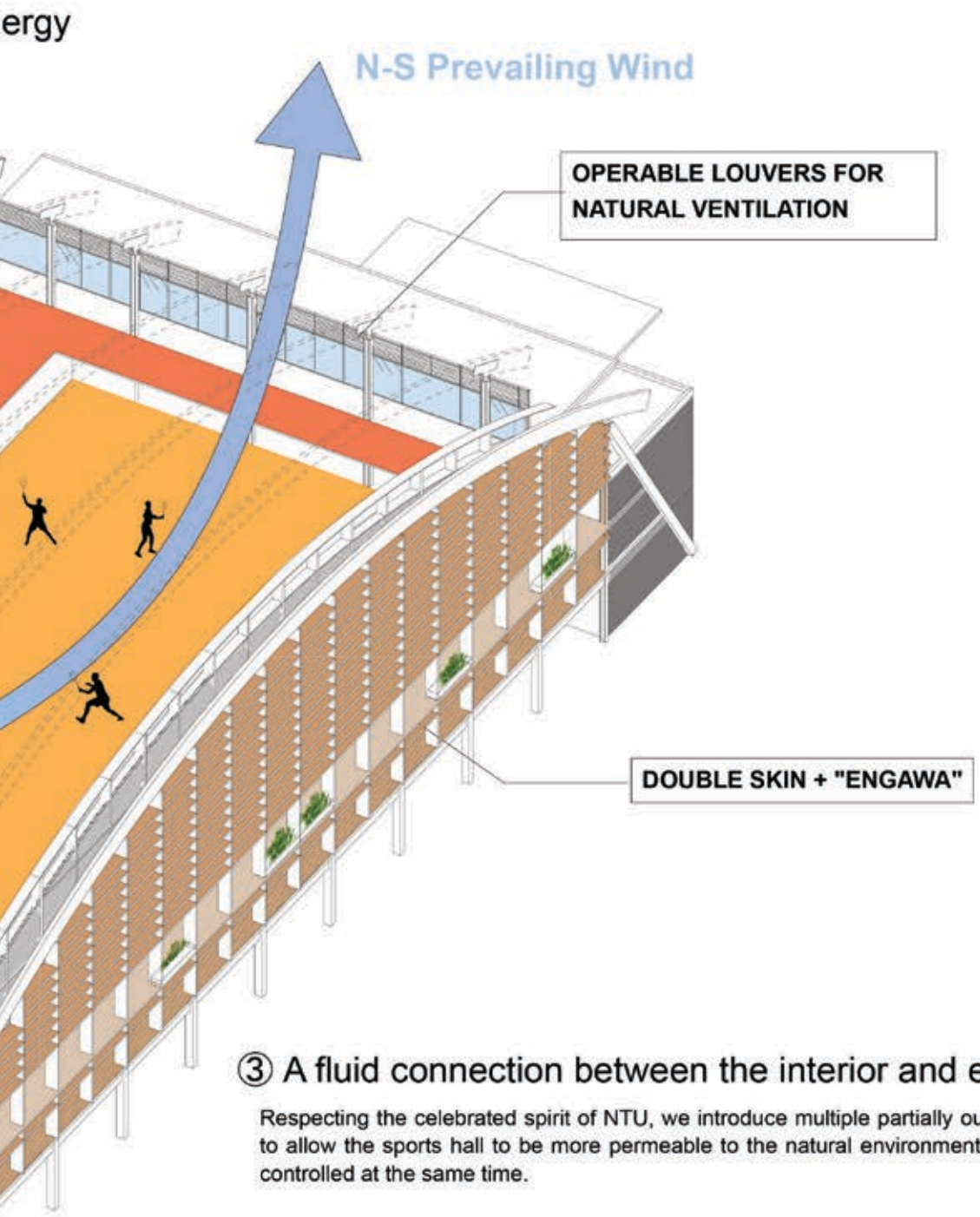


The west elevation

② Create a stablized environment while maximizing use of natural en

By introducing the double skin concept, we create a stabilised environment for the most sensitive and yet most commonly played sports - badminton.
At the same time, the facade is also operable to allow for natural ventilation and natural sunlight to come in when the condition allows.





③ A fluid connection between the interior and exterior

Respecting the celebrated spirit of NTU, we introduce multiple partially outdoor spaces to allow the sports hall to be more permeable to the natural environment, whilst being controlled at the same time.

The use of natural ventilation reduces the need for mechanical ventilation.

treatment system. The sub-meters can monitor water usage and ensure at least seven cycles of concentration at acceptable water quality in the cooling tower system. A heat recovery system will be installed, which will provide the heat for the hot water for showers, in place of conventional, electric hot water systems.

CONCLUSION

The successful delivery of the integrated, sustainable design was guided by the NTU EcoCampus initiative objectives and was facilitated through great teamwork, close collaboration and a strong safety and sustainability culture shared by all project team members. Boasting strong sustainability features, NTU's new Sports Hall is testament to the university's strong commitment towards sustainability. It will be the first large-scale building in Singapore to employ an EWS and has projected energy and water consumption savings of 40% and 30%, respectively. It will also incorporate the use of environment-friendly materials and the design provides for bicycle parking, shower and locker facilities to encourage and support the use of bicycles to get to and from the Sports Hall. The Sports Hall is part of NTU's campus master plan which will propel NTU to become one of the greenest eco-campuses in the world.

PROJECT CREDITS

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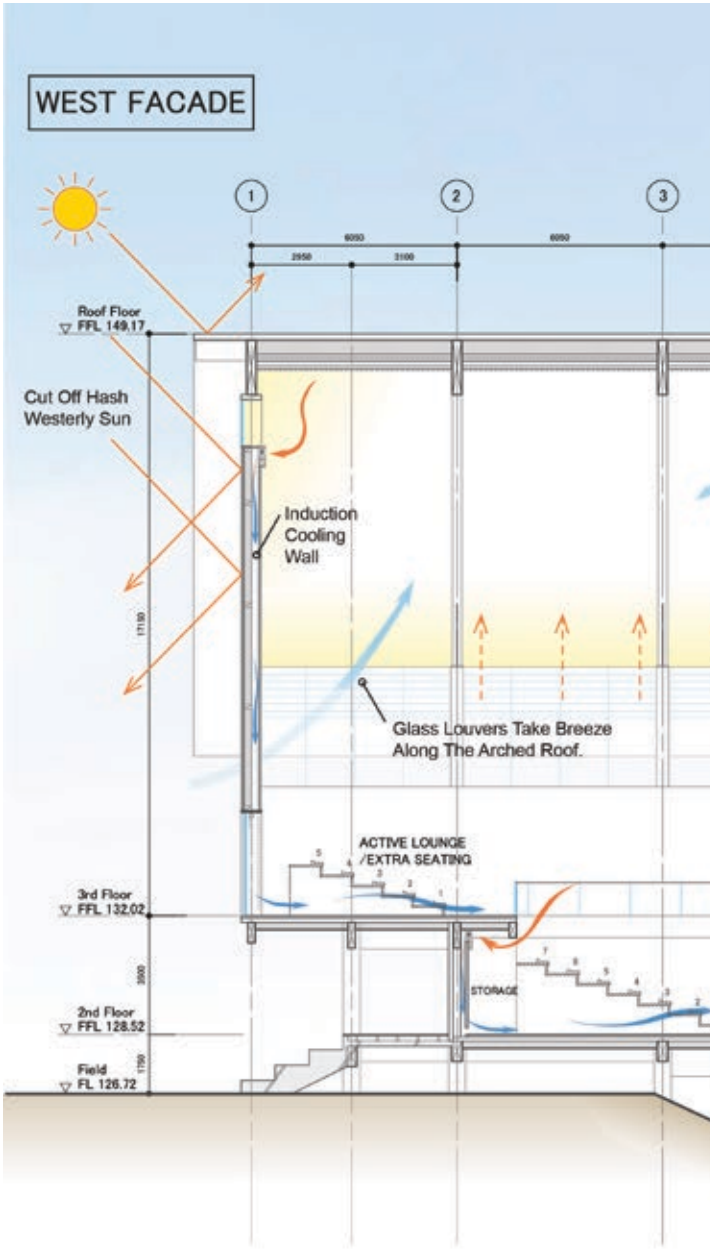

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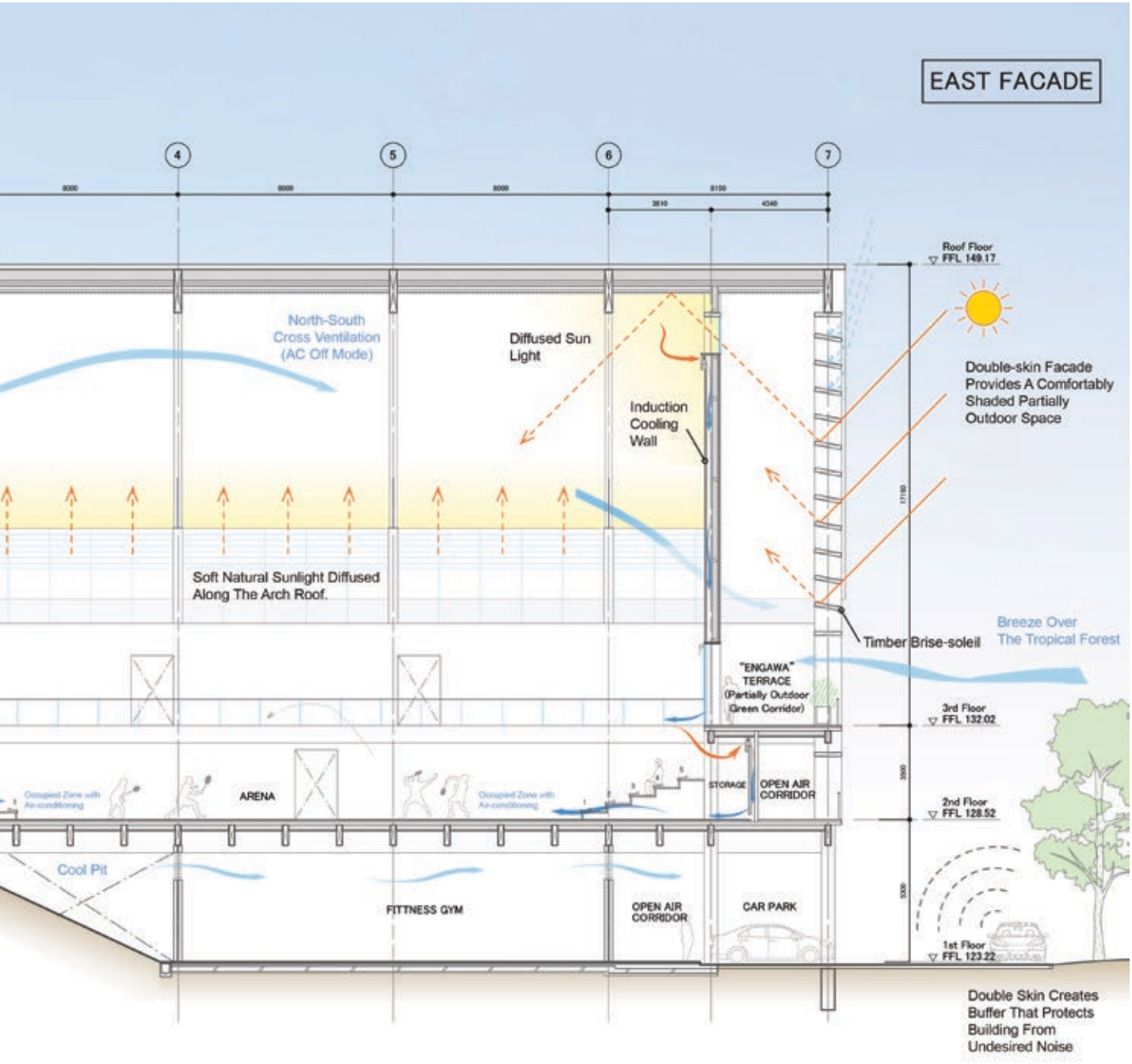

The design allows natural sunlight to enter building whilst also providing adequate shading.