SUSTAINABLE HIGH-RISE BUILDINGS AND APPLICATION EXAMPLES

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Abstract

Application methods for sustainability concept, put forward as a solution proposal for human and environment health problems in daily life are also being researched in the architectural field as other disciplines. Development of design and application methods for high rise buildings in accordance with principles of sustainable architecture has a great importance since they have a bigger amount of environmental charge due to their scale and the intense user population regarding the phases of construction, use and deconstruction. Besides being restricted and consumed in our days, fossil energy sources are perceived more and argued because of giving harm to environment. Architectural discipline, without giving any harms to natural environment via the facts, begins to lead the ecological and sustainable approaches that responds the needs of humanity. In this area high-rise building known as a most energy-consuming building type, during the construction and life time of high-rise buildings, they have most energy consumption and environmental pollution, which is unacceptable. In this context, This study area in sustainable concept includes case study of Lombardia tower in Milan and De Rotterdam tower in Rotterdam as a best examples of high-rise buildings in Europe and investigate The concepts of ecological environment, active energy using and energy saving of ecological and sustainable architectural concepts, green construction and sustainable building principles and methods, in those high-rise building examples.

Keywords-component; Sustainablility; High-rise buildings; Energy eficiency; Active and passive aplications; Case study.

The Concept of Sustainability and Applications of High Rise Buildings

The environment we live in is constantly changing as a result of globalization the developments, to influence the social and physical environment. As a result of globalization, developments, social and physical environmental impacts. Fast-growing countries, uncontrolled energy consumption, all organisms and ecosystem damage and caused the world's energy resources are destroyed. The concept of sustainability in architecture, we live in to minimize the use of energy, water and electricity will be able to control the use of resources, such as the social and economic structure could provide continuity, it will protect people's health and comfort cite some approaches. In this context, ' sustainable design ' live and lifeless in the ecosystem have together all the assets that make health and aims to find solutions to the secure architecture.

"The simplest definition of sustainable high-rise buildings, sensitive to resource utilization every period of assets, does not create environmental pollution, protect the users health and comfort, fulfilling economically these criteria and also the local community building winning the favorable opinion"(H Begeç 2013).

Nowadays, the sustainable design of building construction is seen in different orientations. These are emerging renewable natural resources as the active and passive sources with these orientations. In this context, the sustainable building construction applications as passive and active systems may collect under two main headings.

Passive Systems in High-Rise Building

Passive systems, material and climate according to the data from natural sources effectively taking advantage of the structure can be explained as he is active. As their energy performance of passive system of buildings and building mechanical and electrical and electronic systems, energy efficiency, the building is directly related to the architectural design for the parameters. Within these parameters, the most important are the location of the building, according to other building location, direction, form and building shell can be considered. In the building's energy efficiency, renewable energy sources, leveraging enough passive systems, without the use of any mechanical and electrical system components can be evaluated as a layout created with.

Passive systems that can be granted to the first example, in 1982, the National Commercial Bank in Jeddah is the building (Figure 1). Building the triangle plan schema on atrium and sky-garden fields. The outer façade of stone, while the Tiger sky overlooking the courtyard facades covered with glass. The effect of the chimney a vertical layout of the courtyard the sky by creating air movement and heat in the Interior of the building is 10 ° C, reducing cooling costs up to provide.

Figure 1 National Commercial Bank

The second example, Malaysia in Kuala Lumpur Menara Mesiniaga building (Figure 2). designed by T.r. Hamzah and Ken Yeang; According to the orbit of the Sun by placing them in natural light and passive heating – cooling is intended to achieve. The concept of a vertical landscape in the design of the building, the first floor of the building and, on the side of the building to the top of the building along with the rotating sky courtyard continues up.

Figure 2 Menara Mesiniaga

The third example is Commerzbank Headquarters building which was built in Frankfurt (Figure 3). Tower is shaped as a 60-metre (197 ft) wide rounded equilateral triangle with a central, triangular atrium. At nine different levels, the atrium opens up to one of the three sides, forming large sky gardens. These open areas allow more natural light in the building, reducing the need for artificial lighting. At the same time it ensures offices in the building's two other sides have a view of either the city or the garden.natural lighting and ventilation of the building allows to. 80% of the building natural ventilation provides energy savings up to 30%.

Figure 3 . Commerzbank building

Figure 4 Swiss Re Building

The last example of a passive system, Swiss Re Building is a commercial skyscraper in London's primary financial district, the City of London (FIGURE 4). This building also is the first eco-friendly skyscraper in London. The building uses energy-saving methods which allow it to use half the power that a similar tower would typically consume. Gaps in each floor create six shafts that serve as a natural ventilation system for the entire building even though required firebreaks on every sixth floor interrupt the "chimney." The shafts create a giant double glazing effect; air is sandwiched between two layers of glazing and insulates the office space inside. The shafts pull warm air out of the building during the summer and warm the building in the winter using passive solar heating. The shafts also allow sunlight to pass through the building, making the work environment more pleasing, and keeping the lighting costs down (FIGURE 5).

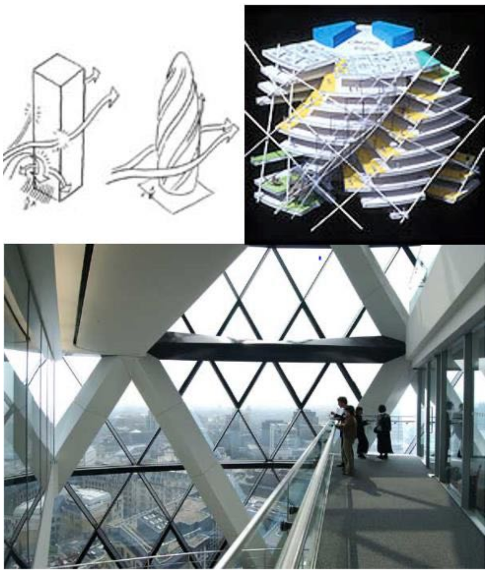


Figure 5 Swiss Re Building

This design approach to the higher structures;

- Facade is a smaller open space between kernel with,
- floor plan is open areas like fields in the atrium and sky-garden,
- the height of the building along the fields Open or mounted continuous or partial format,
- natural ventilation and lighting, we can say that the maximum level could attempt.

ACTIVE SYSTEMS IN HIGHT-RISE BUILDING

Active systems, the energy expended during the use of photovoltaic panels, solar electric motors collector, water purification systems, wind turbines, etc, can be defined as the use of production and with systems. Active systems, architectural design, as long as the device has been involved in during the building's form and passive design building systems that guide the planning of integrated work and increasing the maximum levels of the energy to be obtained for the design target.

It is possible to collect active systems used in high-rise building construction in two main title :

1.Renewable energy-generating applications

2. Applications for energy conservation

RENEWABLE ENERGY-GENERATING APPLICATIONS:

Renewable energy is defined as "the evolution of nature which might be available in the next days, within the same energy source". Solar, wind and geothermal to being as clean energy resources are also renewable natural resources.

Wind energy

In recent years, the use of wind energy in buildings has become increasingly important. Wind energy carbon dioxide emission rate is very low and is one of the most economical renewable energy sources. To benefit from wind energy in building construction if it is with the use of wind turbines.

The height of the structure increases the wind directly without interruption have been in contact with the structure, wind speed is increasing in direct proportion with heights and making use of high buildings with this feature, the turbine can produce significant amounts of electricity. In High-rise buildings design it is necessary to consider parameters such as building aerodynamics, wind speed density, wind turbines in the application design phase site plan layout, wind in the form of local wind patterns, wind speed distribution frequencies and prevailing wind direction,. Therefore, every building have very different features from other.

Forms of application of wind turbines in the building-mounted and building an independent, integrated in the building can be examined in three groups including. Application of wind turbines is mostly in high-rise building is an integrated manner. When the high-rise structures with wind turbine have examined, three ways is seen to be applied, close the roof, lower than the roof sections or between blocks.

There is some famous Examples include Wind turbines in design of buildings, like Bahrain World Trade Center (Photo 6)., the Pearl River Tower (FIGURE 7)., the Lighthouse Tower and Strata SE 1.

Figure 6 Bahrain World Trade Center Building

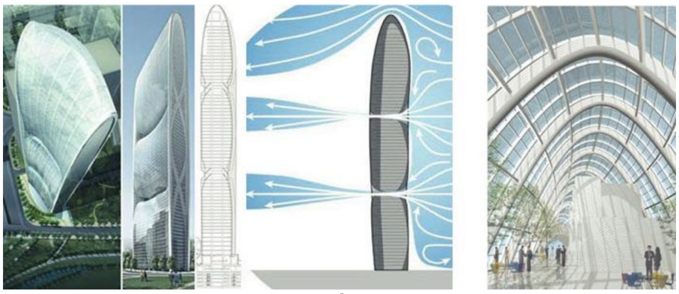


Figure 7 Pearl River Tower

Solar energy

It is possible to produce heat and electrical energy in Building with using solar energy, such equipment like solar collectors, photovoltaic (PV) panels and building integrated PV (BIPV) could help us in in this context. The potential implementation of PV panel in high-rise structure is more high than low level buildings; because as the neighboring buildings higher, is more than the ability to direct solar radiation. PV is the most important issue regarding the use of the structures aesthetics and high efficiency to receive a large amount of PV panel arrangement of necessity.

APPLICATIONS FOR ENERGY CONSERVATION

Materials, water usage, heating, cooling and ventilation (HVAC) systems, building automation and energy systems, high-tech mechanical systems to obtain energy, are applications towards providing and savings energy.

Materials

The three main materials used in high-rise building construction is steel, concrete and glass. Recycled material and/or low CO_2 emissions is one of austerity measures that can be taken. High energy savings in buildings and the material used and implemented in the loss of façade systems is closely associated with the details. In high buildings, glass material is mostly used in façade which have able to reflected the Sun's harmful rays and protect building from Sun's harmful rays. In this way, materials play an important role in the increase of effectiveness heating/cooling and ventilation systems.

Water use

Gray water system and the use of advanced water-treatment system and building façade surfaces with collected rainwater storage and then using the savings achieved are applications for effective water usage.

Heating, cooling and ventilation (HVAC) Systems

Thermal comfort in every climate condition in buildings for the provision of heating, cooling and ventilation (HVAC) systems should be checked good. One of the best ways of saving energy in buildings, building management Systems (BYS) is to provide an efficient HVAC control with. But most of the time, determine the strategies of control of HVAC systems is quite difficult. Essential that the thermal comfort and indoor air quality can minimize the energy costs.

Energy system

Combined heat and power systems of both electricity and heat energy form, is the same system produced together in, also known as cogeneration (FIGURE 8) and three generation systems. For more than 20 years successfully implemented around the world and especially in the last 10 years, the same amount of resources by this method more common input in higher efficiency energy produced. In other words, both the energy of the form separately the amount of required resources for the production, this system is used when more energy is produced. Only electricity-generating a gas turbine or engine with 30-40% of the energy used in electricity being thrown out in these systems, converting the heat energy is used and the efficiency seats up to 70% –90%. Energy efficiency, as well as lower CO_2 emissions in these systems.

Figure 8 Cogeneration Systems

PALAZZA LOBARDIA TOWER/MILANO

Project location	Milano, Italya
Construction start date	2007
Finish date	2010
Number of floors	39
Building height	163 meter
function	Office
The designer company	Pei Cobb Freed & Partners
Construction company	Pei Cobb Freed & Partners
Construction material	Concrete

Figure 9 Palazza Lobardia Tower

The complex is built in reinforced concrete, steel and glass and covers an area of 33,700 m2 between via Melchiorre Gioia, via Restelli, via Algarotti and via Galvani. It consists of a 161,30 metre high tower surrounded by a complex of buildings with a sinusoidal shape which are also of considerable height. The unusual shape of the buildings creates an ovoid urban space structure covered by a transparent plastic material. This 4000 m2 area has been named piazza Città di Lombardia and is considered the largest covered piazza in Europe. The most extensive and scenic open-air space in Milan for organised events.

The complex was designed by the Pei Cobb Freed & Partners of New York architectural studio, Caputo Partnership and Sistema Duemila in Milan. The construction works were completed in the autumn of 2010. The highest tower houses the sala Giunta council room, the press room and the Presidency premises, plus, a conference centre and meeting rooms. Its construction has also facilitated the unification - in the new building and the nearby Pirelli skyscraper - of many of the regional offices that were located around the city of Milan, enabling time-saving and logistical optimisation. (FIGURE 9).

The use of the flowing forms to create a grand, enclosed urban space is compelling for Milan, the city of the great Galleria. There is a quality to the form-making which feels biomimetic and allows for a unique transition to the tower from the urban street wall. Standing as one of the few tall buildings completed in Milan since the mid 20th century, the Palazzo is pushing the design trends of the area in the direction of sustainability, social activation, and contextual responsiveness (FIGURE 10).

Figure 10 Palazza Lobardia Tower curtain wall panels

The ground floor houses predominantly public functions with green areas, commercial malls, restaurants, bars, shops and amenities comprising a kindergarten, an auditorium , a gymnasium, exhibition spaces and a post office.

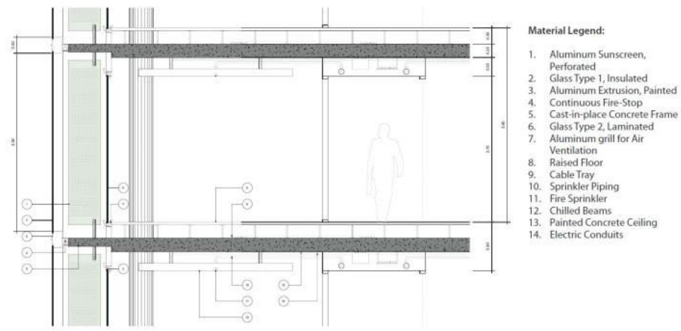
The structure will include a heliport, with a 30-metre diameter and the capacity to support a load of 6.4 tonnes. The construction of the building required 13 million kilograms of steel, and 102,000 cubic metres of concrete. The structure will comprise 72,000 square metres of office space, 7,000 square metres of raised garden, and 33 lifts. The areas of the gardens and squares of the new regional offices are as follows: 3,200 square metres of squares planted with trees, and 3,380 square metres of covered squares, 2,060 square metres portico areas, 6,800 square metres of raised gardens, plus about 200 square metres of green roofs 9,000 square metres of ground-level gardens, 3,300 square metres of areas planted with trees between Via Restelli and the new park.

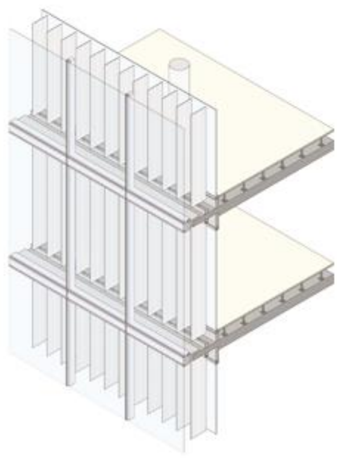
The project - inspired by the harmony of the ridges of the mountains of Lombardy - is decidedly avant-garde with impressive technological solutions. For example, it is equipped with a system of ground water heat pumps, utilised for both cooling and heating purposes. In addition, some of the facades of the tower are equipped with solar panels that provide the energy needed to run the building, plus, a climatic wall, which collects solar heat to be converted. A 550-foot-tall, 41-story tower sprouts at the intersection of two of Palazzo Lombardia's sinuous office blocks. The double-wall system continues all the way to the top of this new distinctive element on the Milan skyline, except on the south face, where building-integrated photovoltaic panels were used. Pei Cobb Freed designed the tower's concave east and west faces as a formal response to the nearby Pirelli Tower's convex profile, but the project also bears a kinship to that modern masterpiece's forward-thinking spirit. Palazzo Lombardia won the award for 2012 European Skyscraper.

The curving, glazed forms of the new building podium integrate effortlessly with the existing buildings and spaces surrounding it. The 14-meter width of these strands of flexible office space allows for maximum daylight penetration, and alternately allows the formation of leaf-shaped voids between them.

Double-skin curtain walls, sometimes referred to as climate walls, come in many shapes and sizes these days. What can be said about all of them is that they inevitably cost more to fabricate and install than your basic single-skin, insulated glass curtain wall. The payout may be recouped in time with cheaper energy bills through increased thermal performance, and there's satisfaction in doing one's part for the environment, but the initial cost is enough to put the system out of range for many projects seeking sustainability. The secret behind Pei Cobb Freed's cost-cutting wall is its repetitive, modular design. In plan, the building fills out an awkward site with four snaking 7- to 9-foot-high slabs that meet in several places to define semi-elliptical public courtyards. At merely 46 feet wide, these office blocks allow ample daylight into the interior. The curves in the plan are all of equal radius. This allowed the architects to spec only two different curtain wall modules, one for the convex curves that are 6 feet wide and one for the concave curves that are 5 feet 10 inches wide. The module widths were also calibrated to match the structural bays, which boast 36-foot spans. There are seven modules per bay on the convex curves, and six modules per bay on the concave curves. At over 11 feet high, all of the exterior modules, which are insulated glass units, run floor to floor with an 11-inch aluminum spandrel unit. The interior layer is a laminated glass unit that runs from floor to ceiling. "The systems themselves are very flexible," said José Bruguera, a partner at Pei Cobb Freed who directed the project team, working closely with lead designer Henry N. Cobb and technology partner Michael D. Flynn. "The interior was also meant to be flexible to meet the needs of each new government, as after every election there is some change."

The 3-foot air space between the two layers of glass is wide enough to access for maintenance and cleaning purposes. It also houses a shading system of micro-perforated vertical aluminum vanes. Controlled by a building management system, the vanes rotate throughout the day to reflect direct sunlight. The perforations maintain a degree of transparency even when the shades are completely closed, allowing dappled light to flow into the interior and views to pass out. The cavity also acts as a return air duct. "In the competition, we didn't have the slab continue all the way to the outer layer," said Bruguera. "There was a grating for walking, so that air could travel up multiple floors. However, local fire code required separation in the cavity, so we brought the floor slab all the way through and designed the air return to be floor to floor." This also permitted the exterior wall to be hung directly from the slab, another cost-saving opportunity that sidestepped the need to design a dedicated truss system for support.





The heating and cooling energy supplied to the building is through a geothermal heat pump system connected to an underground river. Also contributing to the energy supply are photovoltaic panels laminated into the south facade of the tower. The integration of the building's environmental systems in tandem with passive systems and its architectural expression creates an efficient yet elegant high-rise building.

The building utilizes a broad array of green design and operating practices. Among these are green roofs and active climate walls, the latter composed of two layers of glass separated by a one-meter-wide cavity with vertical blades that rotate to provide shade while maximizing transparency of the building envelope. The narrowness of the interweaving strands brings plentiful daylight to all workspaces. In addition, the energy required for heating in winter and cooling in summer will be supplied by a geothermal heat pump system tapping the heat exchange potential of a nearby underground river. Lastly, photovoltaic cells are laminated in the glass panels of the tower's south facades.

De Rotterdam Tower Roterrdam

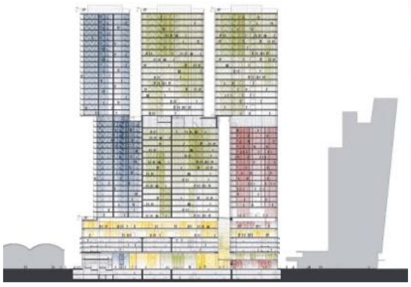
Project location	Rotterdam, Netherlands
Construction start date	2009
Finish date	2013
Number of floors	44
Building height	150 metre
function	mixed use
The designer company	Rem Koolhaas, Reinier de Graaf, Ellen van Loon
Construction company	Brufau & A. Obiol
Construction material	Concrete

Figure 11 De Rotterdam Tower

De Rotterdam is a building on the Wilhelmina Pier in Rotterdam, designed by Rem Koolhaas in 1998 (Figure 11). The complex is located between the KPN Tower and Rotterdam Cruise Terminal and was finalized at the end of 2013. On 21 November 2013, the municipality of Rotterdam, as the largest user, received the keys. The design provides space for offices, a hotel and apartments. The 44 floors amount to a total area of approximately 160,000 m², allegedly making it the largest building in Europe.

The towers are part of the ongoing redevelopment of the old harbour district of Wilhelminapier, next to the Erasmus Bridge, and aim to reinstate the vibrant urban activity - trade, transport, leisure - once familiar to the neighborhood. De Rotterdam is named after one of the ships on the Holland America Line, which departed from the Wilhelminapier in decades past, carrying thousands of Europeans emigrating to the US. The various programs of this urban complex are organized into distinct blocks, providing both clarity and synergy: residents and office workers alike can use the fitness facilities, restaurants, and conference rooms of the hotel. And these private users of the building have contact with the general public on the ground floor, with its waterfront cafes. The lobbies for the offices, hotel, and apartments are located in the plinth - a long elevated hall that serves as a general traffic hub for De Rotterdam's wide variety of users.

Rem Koolhaas is famous for his superlatives – accordingly, his high-rise complex consisting of three towers on the Wilhelminapier in Rotterdam's former port towers up over the district like a massif. "De Rotterdam" takes its orientation from the idea of a "vertical city", whose manifold functions appear to be visibly stacked. Its 30-meter-high base structure houses a parking garage on six levels. An expansive entrance foyer offers ground-floor access to a congress center, restaurants, bars, cafés and fitness studios. The entire complex also boasts offices, 240 apartments and a hotel. The thinking behind this diversity of uses is to contribute to livening up this district in the port area around the clock and encouraging Rotterdam residents to visit the southern part of their city. With 160,000 m² of utilizable floor space on a plot of land the size of a soccer pitch, "De Rotterdam" is the most densely populated area in the Netherlands.



Each tower and block is designed for different and specific functions, and the structural features show the independence of these parts. All functions are interconnected by the base, where employees, residents and hotel guests meet in the services area. The curtain-wall systems allow delineation of different spaces and lighten the overall architecture.

The entire wall system consists of 50,000 m2 of glass, produced by Italy's Permasteelisa under its Dutch subsidiary, Scheldebouw. The curtain wall module measurements are slightly different for the hotel and offices, and the hotel facade has a spandrel at the floor edge. The middle and east towers are designed with custom made profiles, while a standard system profile is used in the apartment tower. In both cases the surface treatment is "natural anodized".

Overall, the design has been pared down to the functionally necessary. What remains are spectacular views over the city and the River Maas out of floor-to-ceiling glass windows. The external façades have been clad with an aluminum post-and-beam construction, making for a filigree appearance which changes depending on the viewer's position. This provides the complex as a whole with its unifying, compact shell.

All areas of the structure are accessible from a large, 8.5 metre high atrium that spans the entire width of the complex (roughly 100 m). This space is characterized by natural stone flooring and wall surfaces, with travertine and brass elements.

The atrium plaza is contained within a six-story base on which three transparent towers are placed. The towers, each with 44 floors, are made of massive overlapping offset blocks, which present an ever-changing dynamic to the building's viewers, seen as "different from every part of the city".

The project director for the De Rotterdam was Reinier de Graaf, who became an OMA partner in 1996. He led several projects in the Middle East and is now Director of AMO, a research studio counterpart to OMA, operating in areas beyond the boundaries of traditional architecture, including sociology and renewable energy.

The sustainability criteria applied to the project inspired fundamental design choices, such as high building density (the floor space index is 32, well above Dutch minimum standards), a dynamic mix of features aimed at greater social cohesion, maximum use of natural light, energy-saving lighting controls, energy production from elevators (with feedback to the grid), reduced-consumption water systems, and finally use of river water from the Maas for cooling systems, with onsite production of "green" electricity through a combined cooling, heating and power plant. With these criteria, De Rotterdam achieves the highest level of sustainability recognized in Holland: GreenCalc "A". Greencalc criteria demand energy efficiency, financial economy in use, maximum benefit from daylight, optimal climate controls, flexible and unrestrained layout, and intelligent, innovative design applications. The technical solutions and systems achieve optimal energy performance in all types of functional spaces. Generation and conservation systems ensure an energy performance co-efficient (EPC) well within building code requirements: apartments are at 0.55 EPC, middle tower offices at 0.82 EPC, and east tower offices at 0.77 EPC (a remarkable 31%, 18% and 23% under the respective code ceilings). OMA had the difficult task of achieving both social and economic growth and sustainable development in creating the largest-ever Dutch building. As Rem Koolhaas said at the inauguration, "the fact that De Rotterdam stands today represents a small triumph of persistence for the city, the developer, the contractor and the architects".

CONCLUSION

In the past, which is a major energy consumer, high buildings, nowadays very much to benefit from renewable energy sources, sustainable progress began to be made as well. However, many companies still have more of the cost of the initial investment, making it the biggest obstacle in making sustainable are seen as high. Research conducted within 15 years of their high initial investment costs they pay for the buildings and business expenses, they provide more benefits to the health of users reveals the.

Our destinations be made sustainable high structures and is vital to the future of our planet. There's more individual structures will not provide an effect. Sustainable high structures are mostly done with the climate, the environment and human health benefits can be achieved.

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