

论城市设计的生态补偿作用

——记舟山临城新城中心区城市设计的生态策略

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摘要:城市设计在发挥控制城市形体环境、整合城市运行系统的作用的同时,其生态补偿的重要作用必须得到重视和贯彻。通过对舟山临城新区城市设计的实际案例分析,探讨如何在城市设计中从4个可操作的方面来进行有效的生态控制和补偿。

关键词:城市设计;生态补偿;控制要素

Ecological compensation in urban design: A case study of the urban design for the centre of Lincheng New Town, Zhoushan City

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Abstract: Urban design addresses the issues related to the control of the physical forms and environments of a town, the management of its multiple systems, and the operations of ecological compensation. This essay is intended to introduce four effective ways of ecological control and compensation in urban design by studying the case of designing the new town of Lincheng, Zhoushan city.

Key words: urban design; ecological compensation; dominating factors

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The city is a complex living system, integrating various elements such as nature, economy, society and culture. The city is understood to be both the product of and generator of massive economic and social activities^[1]. However, creation of a city or town will unavoidably break the existing balance of natural systems. In order to achieve sustainable environmental outcomes in development, how to harmonize the dynamic relationship between human building activities and the conservation of natural systems has emerged as a new challenge for designers, in the context of the massive recent growth in urbanism in China.

Apart from the physical shaping and multi-system managing of a city, the operation of ecological compensation must be carried out throughout the whole process of design. The concept of ecological compensation used in this study is something different from its meaning in ecology, which puts more emphasis on the equality in quality and quantity. This is manifested in two woven environmental aspects: one is to compensate the loss of nature in artificial construction, while the other is to inspire nature to actively respond to the new urban environment. As an artificial product, the amount of eco-compensation is significant for the loss of environmental quality. Urban designers should therefore work between artificial and natural environments, taking the ecology value into account in actual projects.

Commissioned by the Urban and Rural Construction Committee of Zhoushan City in February 2001, we participated in the urban design project for the town centre of its administrative and showcase new town, Lincheng. Lincheng sits between the two traditional towns of Dinghai and Putuo, and is bounded by sea to the south and mountains to the north (Fig. 1). The city

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has a typical Semi-tropical Oceanic Monsoon climate with distinctive seasonal characteristics. Although the site currently comprises flat cultivated lands, the height levels between the land, road, and sea-embankment vary greatly.

Construction of the new town was aimed at moving the city's administration centre out of the traditional town of Dinghai. Whilst the aim was to inspire development through both protecting the existing developments and expanding the city, it was acknowledged at the same time that the substantial human interference necessarily involved, would break the original ecological balance in the new town, resulting in demolishing its existing landscape. This presented the challenge of how to efficiently manage the landscape and ecological systems in the context of demolition and construction. In response to this challenge, an emphasis was placed on four elements in the design to balance the ecological environment and human construction (i. e. weaving natural and artificial elements). These elements included the landscape, water system, plantings and buildings:

(1) The natural landscape was the most essential aspect as its artificial modification is the most difficult to repair. This problem was acknowledged as deserving careful consideration. (2) The water system can be divided into two sub-sectors; the natural water system and rainwater drainage system. The natural water system is important for adjusting climate and flooding as well as preserving the diversity of bio-species. It was hoped that by regulating the natural water system and establishing the rainwater drainage system, construction activities would result in a lesser impact on these systems. (3) The planting proposal had two aspects; the preservation and maintenance of original plantings, where possible, and the rehabilitation of any destroyed botanic environment. (4) Buildings, as a kind of artificial construction, are ecologically harmful to the environment. Special techniques were applied in their design to ensure they integrated with their natural environment.

1 Landscape

Lincheng is characterised by sea embankments at a height of 3.14 m forming the southern edge, with the inner lands being mostly flat, with an average height of 1.5 m. It is regulated that the height of roads and buildings should not be lower than that of the sea embankments to reduce the possibility of inundation by flooding. Conversely, if the whole site was filled to reach the height of 3.14 m, the result would be not only the cost of enormous earthworks, but the reconstruction of the natural landscape, necessarily involving defacing the existing terrains, rivers and plantings and the demolition of the location's familiar environments. Such works shows little respect for the original landscape and would result in immense ecological risk^[2].

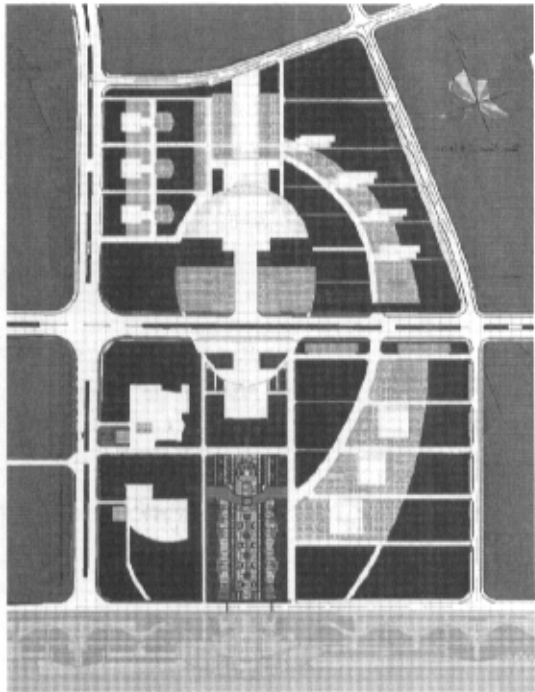
In response to this problem, three solutions were taken at corresponding levels (Fig. 2).

1.1 Taking the site as a whole, most land is well kept at the existing height.

The existing land has been reshaped many times in history for cultivation, resulting in a relatively flat topography over



Fig. 1 Site location



- 1 Most land is well kept at the existing height.
- 2 At the transportation and functional level, the roads and buildings are raised to 3.14m to ensure connection to the exterior road system.
- 3 On the secondary transportation and functional level, the roads and landscape, platforms are built on stilts to maintain the original eco-flow.

Fig. 2 Three solutions at corresponding levels

most of the site. This sort of character is preserved in most areas, such as the proposed lawn and woodland, so that the fertile earth can still be used. Conversely, along both sides of the Sea Culture Square, the land is re-shaped according to the orders of nature, such as rain, surface runoff water, loads, and underground water level. It is proposed that the new landscape will be sculpted through filling and piling earth to form a new eco-edge. From the interpretation of Fig. 3, it is clear that piled earth on sloping surfaces will bear gravity loads, scour from storm water, and wash from surface and underground storm water runoff, which will result in a landscape that is easy to move and reshape^[3]. Accordingly, the essential method to keep a sloping configuration is to control the surface storm water runoff, by applying measures such as building storm water capture channels, sluice pools, barrel-drains and other drainage systems on slopes, to regulate the streams. Fig. 4 shows our contribution to the drainage system for the eco-lawn, which aims at the stabilisation of the sloping configuration. These drainage facilities will hold a certain amount of fresh water, which can be used for irrigation in dry seasons, beneficial in a location that is seriously lacking in water, such as Zhoushan.

1.2 At the transportation and functional level, the roads and buildings are raised to 3.14 m to ensure connection to the exterior road system.

Pipes and lines are laid under the main roads and buildings.

These piled structures lie across the plain and result in a well-ordered corridor system, which works with the barrier of filled earth to avoid losing deposits. Planting belts at a certain width are laid on both sides of the road for protection.

1.3 On the secondary transportation and functional level, the roads and landscape platforms are built on stilts to maintain the original eco-flow.

There will be a rich variation at different levels of height between the artificial platform and natural land level, which will result in a series of squares, steps, pavements, and platforms, and therefore various spaces to accommodate different activities. In this way, all of the places will be provided with 'boundary effects'. Fig. 5 interprets the above presentation with typical sections.

An important ecological concept runs through the reconstruction of landscapes. Through years of cultivation, the site loses its natural features and becomes isolated within its original context. Urban design should simultaneously guarantee the functions in regular grids, but also declare the natural system, by simulating the landform around.

2 Water system

2.1 The natural water system

The site has a pleasant water environment, comprising a wandering river with abundant plants on both sides, interspersed with drained highlands. Calculations show that the existing water system carries 201 000 m³ in volume. However, once the natural landscape is rebuilt, less water will penetrate to the underground system, resulting in an increase in surface water. Furthermore, as planning for the town must be strictly ordered, the conflict between artificial and natural topographies is unavoidable.

The amount of deposited water has consequences for both the local climate and the growth of the ecological systems^[4]. Indeed, the **万方数据** meadows and swamplands are the habitats of many special creatures. In response to this issue, two principles have been adopted: first, to ensure the existing amount of deposited water is conserved; and secondly, to preserve

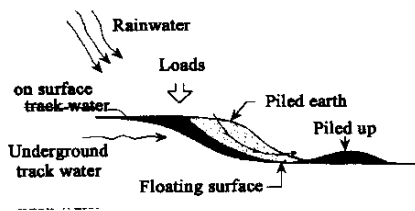


Fig. 3 Slope surface dynamics^[3]

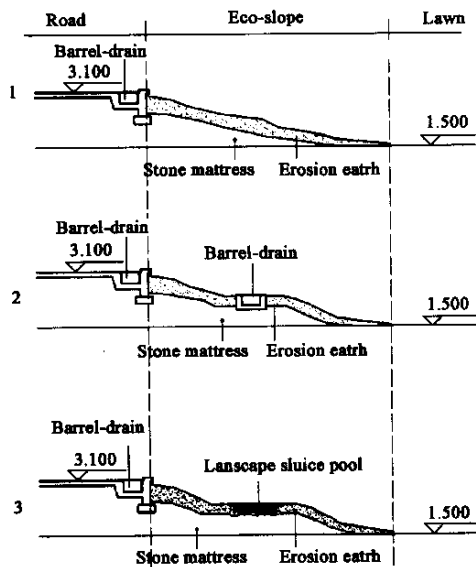


Fig. 4 Slope configuration

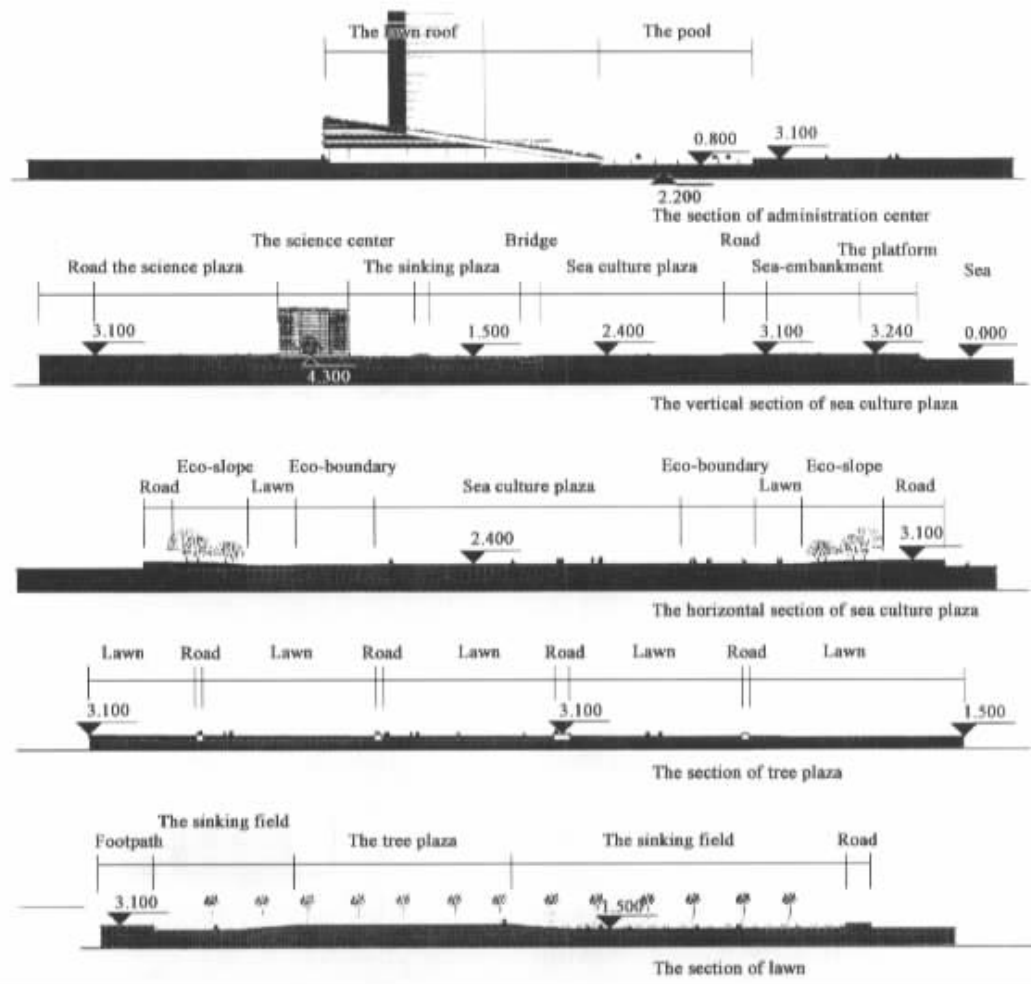


Fig. 5 Typical sections

and re-frame the existing watercourses so that the intention of design would be manifested, without losing the original atmosphere. The formula for calculating the amount of deposit water is as follows: ‘water volume = surface area of water body × water depth’. Artificial construction will usually make the ground surface impermeable to water, which means the sluice ability of ground pools will be weakened. In this sense, expanding the surface area of the water body is essential to supplement the lost deposited water from the ground surface. In addition, the shape of the water body will also affect the deposited amount. For instance, a river with a shrinking and expanding surface width will store more water than a straight stream. Thus, in accordance with the above principles, the proposed design focuses on reshaping the water system and reconfiguring the riverside. In particular, the natural topographies were taken into account such that, through its shape, the water system could store more water. Fig. 6 shows the comparison of the original and proposed channel.

The following are policies aimed at integrating the natural water systems within the various topographies, whilst ensuring that the existing landscape characteristics are reinforced and protected. First, along the axis of the Sea Culture Square, a wide, slow flowing water surface is to provide an ambience of

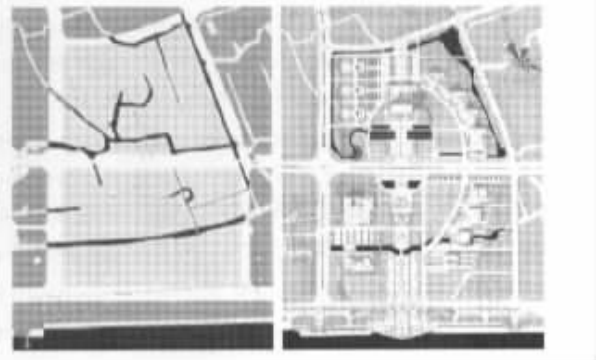


Fig. 6 The comparison of original channel and shaped channel

grandeur. Secondly and conversely, the water body across the woodland is designed as watery downfalls, aimed at providing an environment for the sustainability of the surrounding plant life. Thirdly, on the open lawn, the riverside is designed to be flexible enough to afford its continuous reshaping from natural erosion. Fourthly, at the water shore, accessibility and safety are the key points for design.

The design of the boundary between land and water is intended to avoid interference from the riverbank and to ensure a calm flow of water. A variety of techniques were applied in this design, including the natural bank, platforms built on stilts, regular boundaries, and terraced bank, all of which are detailed in Fig. 7. By reshaping and renovating the riverbank, the water surface will be enlarged so that rainwater drainage is direct and the flooding discharge ability is substantially increased. The amount of deposited water in the design is 246000 m³, including an additional 45000 m³ to contain potential floodwaters.

Nature has a magical power of self-organisation and adaptability. The whole earth survives and thrives in nature’s adaptation. That is to say the complexity and abundance of natural systems are far beyond the design ability of human beings. In this case, it would be better to take advantage of, and work with, the self- organising and self-design processes of nature. Ecological design means making full use of the adaptability of natural systems^[5].

2.2 City rainwater drainage system

2.2.1 Water collection system Zhoushan is a city seriously in lack of water. Due to its island location and special climate, rainwater is mostly available in the rainy season (not evenly distributed in space and time), which is primarily brought by storms. Statistics show that water in the urban rivers amounts to 574 million m³, of which 70% remains as surface water. Apart from a limited collection by reservoirs, most of the water is conveyed to the sea. In this case, an underground water tank is proposed to store and purify the rainwater for reusing, for example for irrigation or in water landscape features. This kind of low-cost way is abbreviated as the SSBB method, which has been put into practice in Japan. As is shown in Fig. 8, the blue rectangle refers to the underground water tank, assembled with high compression resistance units. The tank is placed a little higher than the river’s Warning Limit, wrapped with waterproof cloth at the bottom and permeable materials at the top, so that rainwater can penetrate the surface into the container. The purified water is released via an exit at the bottom left-hand side of the tank, which is specially designed for the maximum use of water even in dry seasons. River water comes into the tank from an entry at the top right-hand side of the tank, which is vertically placed at the same height of the river’s Warning Limit. This is an application of the “connected vessels” principle, which means water over the Warning Limit could come into the tank for storage or drainage, and therefore release the pressure of flooding. Despite the reduction in cost, concrete tanks cannot be laid underground in the SSBB method. Instead, the engineering is as simple as piling up small and light containers quickly, which are stronger and more enduring. Calculations indicate that each of these facilities could store 100 mm of rainwater per hour, which is proved as an effective way for recycling.

In addition to this method, permeable paving materials are also advisable for use in construction of surfaces, so that rainwater can penetrate the earth, to protect the meadowland eco-system. The following are the suggested methods: first, roads are laid with porous asphalt or concrete; secondly, permeable planting surfaces are used for secondary parking and emergency driveway areas; and thirdly, pedestrian surfaces are covered with loose granulated materials. Well-designed timber board and paving materials are also recommended.

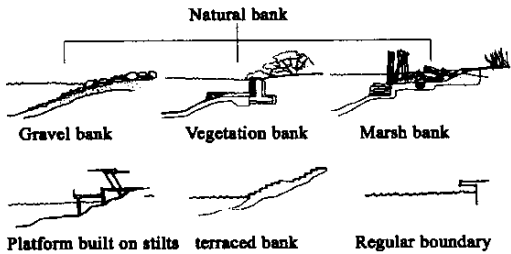


Fig. 7 Multi-way of riverbank^[3]

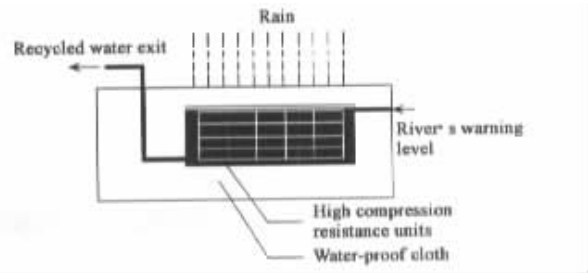


Fig. 8 Special Service Buy Back(SSBB method)

2.2.2 The water circulation system design for the administration centre The water circulation system was designed by studying the relationship between the lawn and water pool. The water pool in front of the eco-lawn is expected to accommodate any rainwater runoff. In case of overflowing, the water will be sent to tanks (7) via pipes. Meanwhile, these tanks are also responsible for storing the roof-surface rainwater runoff. With the aid of pumps (8), the tank water will be recycled in the following three ways: first, as irrigation for roof gardens; secondly, in landscape water features; and thirdly, as non-drinkable water for daily use. Water that has penetrated the eco-lawn would be collected by appendices (4) and stored in the slot at the front edge of the lawn, which is then purified by the sedimentation (6) and sent to the storage tanks. This flow is illustrated in Fig. 9.

Declare Being, as an important principal in ecological design, has gained more emphasis in modern society. At Lin Cheng new town, the proposed water system design declares and accentuates the natural phenomena. The conduct, collection and recycling of water have been special focuses for urban ecological design. In this process, ecological and engineering considerations have together been taken into account, to produce optimal outcomes in terms of both sets of parameters. One result is that the engineered outcome simulates ecological processes to sustain landscape and biological diversity.

3 Planting

Table The wind break results of different structure forest belts						
Percentage of wind Speed	0—5 times of the tress' height	5—10 times of the trees' height	10—15 times of the trees' height	15—20 times of the trees' height	20—25 times of the trees' height	25—30 times of the trees' height
Solid structure forest belt	25	37	47	54	60	65
Semi-Sparse structure forest belt	26	31	39	46	52	57
Ventilated structure forest belt	49	39	40	44	49	54

Note:assume the wind speed in weald for 100%;Derived from Institute of Forestry and Soil Chinese Academy of Science;P. 52 in Urban Plant Ecology

Lincheng is a windy town, which is due to its seaside location and semi-tropical oceanic monsoon climate. On the whole, this is a negative characteristic, and a windbreak forest is therefore essential for protection. In the eastern part of the site, a forest belt has been designed which works with individual trees on all kinds of platforms, that are regularly planted to protect human activities.

3.1 The windbreak belt is structured as semi-sparse forest. As shown in the analysis in Fig. 10, this is comparatively more effective for protection (at a distance of 25 times the tree's height).

The forest is comprised of two main kinds of trees, broadleaf arbor and bush; the former is planted in the middle of the belt and the latter is planted on each side. According to the wind-speed percentage and tree height test, the best height for a windbreak forest is about 5 m. Supposing the trees are 5 m high, the effective windbreak distance is about 125 m.

3.2 The individual trees regularly planted on the platforms are intended to be provided as ventilation walls, which are able to reduce the wind speed significantly, while also providing shade for people. It is proven that within the range of 0—25 times of the tree's height behind the forest, the wind speed is only 39%—49% of the original. Again, for trees that are 5 m in height, the effective distance is 125 m.

3.3 The vertical interface between the raised platform and sinking area is provided as a solid structure for the windbreak.

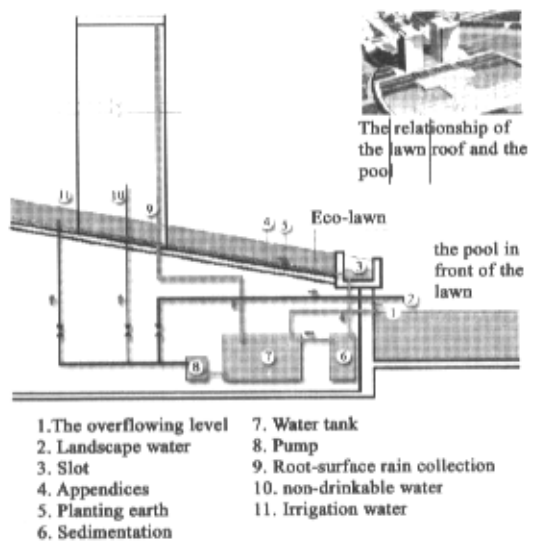


Fig. 9 The scheme of Water Circulation System for eco—lawn

According to Illus. 1, its effective distance is 20 times the tree’s height. For example, where there is a height difference of 1.60 m between the raised platforms and sinking area, the ‘wind shadow distance’ is about 32 m behind.

Fig. 10 was prepared according to the above calculations. The yellow arrows are for the direction of wind from the sea; the blue area is for the windbreak forest’s effective area; the green area is for the area protected by the individual trees; and the cyan area refers to the ‘wind shadow’ made by the solid interface. It is clear that the curving forest belt shelters most of the elevated pedestrian spaces, while the individual trees provide better microenvironments for people. The meadows have already been shadowed.

Along both sides of the linear spaces, such as river valley and roads, planting corridors have been proposed to buffer the negative affects from human activities to nature. It is understood that the insertion of roads splits the natural areas, which are to be repaired by the following planting policies: first, lay green belts, comprising a mix of arbours and bushes, of a certain width on both sides of the main roads; secondly, plant liana and bush wood under the elevated roads and platforms to control erosion and preserve soil humidity; and thirdly, a variety of planting methods are to be used to diversify the botanic layers and build pleasant eco-spaces.

As already mentioned, the land is currently covered by crops, making it difficult to distinguish the original local plants. A selection of the original, secondary, and artificial plants from the nearby forest were therefore taken for planting selection reference. Plants that are suitable for seaside growing, such as Camphor Tree, Red Nanmu, Japanese Cassia, Glandular Oak, Hackberry, Chinese Elm, Beautiful Sweet gum, Bunge Spindle Tree, Chinese Wing nut, Japanese black pine, Masson Pine, and Bamboo were chosen for the site. As an important habitat for sea birds and principal station for migratory birds, it is hoped that Zhoushan will become an ideal and safe place for birds, with abundant trees and flowers.

4 Buildings

Due to the large numbers of meeting and exhibition spaces, the Administration Centre was unavoidably a massive volume construction. Conceptually, a ‘lawn roof’ was proposed, not only for landscape continuity, but also as a sustainable approach to ecological enhancement and energy saving. On one hand, by placing the parking space under the ‘lawn roof’, more surface area will be released for greenery. On the other hand, the planted roof will function as a huge insulation layer to reduce the radiation heat absorption rate^[7]. This provides for a more stable indoor temperature, reducing the need for air conditioners. Fig. 11 provides a detailed explanation of this idea.

The local windy weather makes buildings vulnerable to sea wind, especially in open fields. When air currents hit the walls in their path, large amounts of turbulence result^[7]. As an effective resolution, most buildings in the design are elevated and the walls are slotted, so that the air pressure between the front and back of the construction is released. For example, the Science Centre sitting on the central axis is designed as a huge gate for wind channelling, which simultaneously makes the views transparent. The Exhibition Centre, Art Museum, Bookstore and Library are all elevated according to the same eco-design principle. Fig. 12 is a perspective view of the Science Centre, where the yellow arrows are for air currents passing



Fig. 10 The wind shadow region



Fig. 11 ‘Lawn roof’ of the Administration Centre

through the ‘wind channel’.

The project for Lincheng is to be implemented soon, and the Urban and Rural Construction Committee of Zhoushan has accepted our conceptions and principles. The Municipal Administration Centre, a 28-storey building designed by us, is also to be built in the near future. The theory of eco-city and green architecture is now widely accepted and even becoming a popular term. However, practicing this term is an essential aspect of the term itself, and which is fundamental in our project of Lincheng.

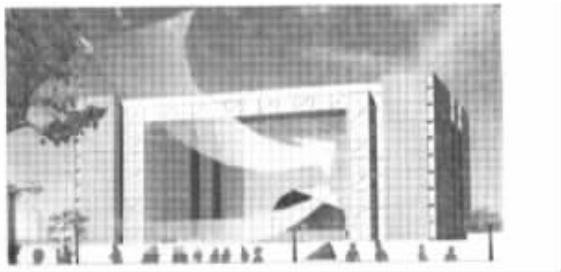


Fig. 12 The Science Centre

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