Scholars Journal of Engineering and Technology (SJET) **ISSN 2321-435X (Online)**
Sch. J. Eng. Tech., 2014; 2(3B):423-425 **ISSN 2347-9523 (Print)**
©Scholars Academic and Scientific Publisher
(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Review Article

Exploration of Low-technology Energy Conservation Design for Natatorium

Liang Qiao
School of CML Engineering, Northeast Petroleum University, Daqing-163318, China.

***Corresponding author**
Liang Qiao
Email: 42007723@qq.com

Abstract: Sustainable economic development requires the building of a conservation-minded society. Therefore, it is an architect’s obligation to realize the goal of building energy efficiency. High-tech energy-saving technology for buildings requires large investment, and its slow effect and low popularity rate prevent its development. In contrast, low-technology building design is more favorable for energy saving at present. This paper explores the methods of low-tech passive energy conservation design in the plane layout, elevation design, and roof design of natatorium.
Keywords: plan; energy conservation; Layout

Energy Conservation and Plane Shape

Building’s plane shape is an important indicator for energy conservation. Shape coefficient of buildings greatly affects its energy consumption. The bigger the coefficient is, the more heat and energy per unit space is needed. Small coefficient is advantageous for decreasing heating energy consumption. Large as the natatorium is, good indoor space designs will help save energy [1]. When the size is the same, different space designs have different energy consumption. Based on theoretical analysis and energy consumption analysis, we may come to the conclusion that in terms of energy consumption, the shape of triangle costs the most, followed by rectangle, square, hexagon, octagon and cylinder. That is to say, polygonal shape is more energy-consuming, and the best choice of shape is cylinder.

Shape coefficient also affects the plane layout of the building. Small coefficient means less concave-convex changes, which may result in the drabness of buildings design. While too many changes will inevitably increase the coefficient and the result is energy waste. Therefore, in the design of the natatorium, all factors should be taken into consideration. We should seek for the variation of design without violating the demand of coefficient. Based on the construction standards of public building shape coefficient, the shape coefficient of natatorium should be controlled within 0.3. Surface area of natatorium should be reduced in its external design; there should not be too many concave-convexity changes. For the purpose of energy conservation, we may increase the length and depth of natatorium and control its height.

Energy Conservation and Function Layout

(1) Overall function layout

On the one hand, plane layout of natatorium confirms to the requirement of coefficient control; on the other hand, it contributes to the reasonable arrangement of the rooms of different use functions. Functional space layout and plane arrangement of the natatorium affect its usage rate, convenience and operating cost, which will in turn influence its energy conservation effect.

Generally speaking, natatorium includes swimming section, grandstand, logistics management office, and referee and organization committee office. The most important sections that are frequently used are the swimming pool and the grandstand (in natatorium for sports events). In order to improve its usage efficiency, they should be placed in the center of the natatorium with direct connection to the entrance. Rooms of other functions might be set independently; the auxiliary space and transition space of swimming pool should be fully utilized. From the perspective of building’s physical environment, the functional sections of natatorium could be divided based on their setting temperature. According to thermal comfort degree, the space can be divided into space with high comfort level requirement and that with low comfort level requirement. For space with low comfort level requirement, it could be placed on the north side or external side of the building. A “heat-damped area” could thus be formed for the hall of swimming pool.

The loss of radiating heat can be reduced and energy for heat-supply will be saved.

(2) Layout of pools

Large-scale natatoria have swimming pools and diving pools, some of them also have training pools [2]. Based on their functional orientation, different layout of the pools has different effects on energy consumption. There are two types of arrangement. Swimming pools and diving pools could be set within the same functional space, or they might be set in two different functional spaces.

These two types of pool arrangements are different in terms of space usage and energy consumption. Both of them have their pros and cons. The former mainly adopts parallel arrangement with clear functional differentiation and streamlined structure. Facilities and subsidiary rooms are more convenient to plan, equipment costs are relatively low, and the space atmosphere are capacious and grand. However, these two types of pools have different requirements for height. Placed in the same space will result in space and energy loss. For example, Jinan Olympic Sports Center Natatorium placed swimming pools and diving pools in the same space (Fig 1). Diving pools with different height needs are set differently. The design has the advantage of flexible and independent space layout, free graphic design, economical space and air conditioner use. It is useful in energy conservation, but it also has certain disadvantages. The separated space setting causes decentralized audience setting and the plane layout is not compact enough.

Fig-1: Jinan Olympic Sports Center Natatorium

(3) Size control of grandstand

Grandstand in natatorium for sports events is very energy-consuming. Its energy consumption for cooling, heating and illumination accounts for 30% to 40% of the total. In terms of scale, the grandstands have different size – extra large, large, medium, and small. Considering usage rate after competition, large grandstand, which has 3000 to 6000 seats, should be constructed prudently. Small natatorium could meet the demand of both big competition and the public. It should be the trend of future development. The seats could be made retractable, so that they can be retracted when they are not needed. This flexible design can provide more space for other events, since the edge distance of the pool could be increased. The natatorium's function will still be brought into full play even after the competition. For example, National Olympics Natatorium in Beijing (Water Cube) could accommodate 17,000 audiences, in which 6,000 seats are permanent, and the rest 11,000 are for temporary use only. The natatorium is fully used both during and after the competition. The operation cost can be reduced after the competition and more energy will be saved.

Energy Conservation and Elevation Design

The development of construction technology gives richness and vitality to building elevation. Building elevation represents the image and language of architecture. Now, with the principle of low-carbon and sustainable development in mind, we should pay more attention to energy conservation when aesthetic requirements are fulfilled. It is especially important for the design of energy-consuming natatorium. For the purpose of energy conservation, this paper proposes some methods in elevation design, such as window design (area ratio of window to wall), the control of color on the façade, and the application of some new techniques and new materials.

(1) Energy conservation and window, wall elevation design

Windows generally account for 30% of the exterior structural area and 2 thirds of the total energy consumption. It is the most energy-consuming part of the building, therefore, for energy-saving, windows are the key factor for exterior part. The control of window and wall area is one of the important indicators of building energy conservation. Window and wall area should be properly restricted without affecting sun exposing, lighting, ventilating and viewing. Because of its special need of spatial form, the elevation of natatorium is usually constructed in accordance with the roofing structure. A reflection glass curtain wall or a curtain wall with windows is set. For its spatial span is large, the light is insufficient in the inner hall. So, natatorium needs large side windows, since traditional side window lighting cannot meet the luminance need. In order to avoid the influence of glare in the swimming pool, the area and position of side windows should be properly designed. To solve the contradiction between window area and window position, roof lighting should be used and large side windows should be replaced by small high side windows. In this way, the area ratio of window to wall can be decreased, and at the same time, the lighting demand can be satisfied. It is the best choice for energy conservation.

(2) Energy conservation and integrated elevation design

Because of its special need of spatial form, the elevation of natatorium is usually constructed in accordance with the roofing structure. Natatorium's elevation mould affects its shape coefficient as well. The control of shape coefficient has already been mentioned in the discussion of plane energy conservation design. Here, the influence of façade color on building energy conservation will be discussed. According to color study, dark color's ability of heat absorption and heat collection is stronger than that of light color. In summer, in order to reduce heat absorption, lower the temperature of the building surface, and relief the workload of interior air conditioner, materials of light color are adopted. It is precisely the opposite for winter. For the construction of natatorium, climatic features and building orientation should be fully considered in selecting the surface color so as to save energy. To be more specific, we should think about its climate, geographical condition, and energy consumption ratio between summer and winter. For example, Shenyang Olympic Sports Center Natatorium is located in cold regions. Its south elevation combines red wall with reflection glass curtain wall. This design will contribute to heat absorption in winter and reduce the load of interior heating (Fig 2).

Fig-2: Red Wall of Shenyang Olympic Sports Center Natatorium

Energy Conservation and Roof Design

Generally speaking, natatorium is large in size, special in structural style, and complicated in internal function. Therefore, it is hard to meet all the demands from all aspects – spatial formation, function organization, style design, and ecological and energy saving. The constant water evaporation of swimming pool leaves the environment humid. Steam rises to the roof constantly, so damp proof and corrosion prevention is a required quality of the roof. Natatorium without air conditioners should mind the cleaning of dew and condensed water. Arched or sloped roof form is preferable. Therefore, the selection of roofing structure of natatorium should be flexible in accordance with its function. The use of slope is good for anti-condensation and water draining. Proper structure and simple components are also necessary. All in all, the design should be aesthetically pleasing and ecologically friendly. At present, natatorium mainly adopts grid structure and suspended-cable structure. Light in weight and wide in span, grid structure is suitable for various plate forms and architectural modeling, but it has the problem of moisture condensation. Without air conditioners, water may flow down along the pipe like raindrops. More attention should be paid to avoid the corrosion of steel pipes. Suspended-cable structure is light, flexible, and curvaceous. However, its lightweight makes it vulnerable in strong wind. In design, special attention should be paid to its anti-wind capacity so as to make it more stable. This structure is also widely used in natatorium.

CONCLUSION

To conclude, proceeding from ontology design of natatorium, the purpose of energy conservation will be realized through low-tech passive design. Temperature division in plane layout will fully utilize the functions of different sections. Under the premise of proper lighting, elevation design should reduce window area and pay attention to the color design. As for roof designing, the need for anti-condensation and water draining should be met. Simply put, to create a comfortable spatial environment, the overall design should be reasonable, economical and energy-saving.

REFERENCES

1. Wang Jing, Zeng Jian; Design Analysis of Ecological and Energy Saving for Large-scale Stadium. Architect. 2008.
2. Li Linghua; The Research Modern Swimming Diving Hall Architectural Design. Hunan University. 2006.