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AGENDA ITEM 7: AVIATION AND ENVIRONMENT

APPLICATION OF THE PREFABRICATED ALS BRIDGE AT MOUNTAINOUS AND WATERFRONT AIRPORTS

(Presented by the People's Republic of China)

SUMMARY

To cope with a series of problems in conventional construction mode of the approach lighting system (ALS) at mountainous and waterfront airports, such as severe ecological damage, huge project investment, inadequate spanning capacity, difficult maintenance, high safety risk, slow emergency response and long construction period, China proposes to build a prefabricated bridge solution for the ALS in these situation (hereinafter referred to as "ALS Bridge"). It has been successfully applied in several airports including Shiyan, Guiyang, and Tengchong, avoided the ecological impacts caused by the conventional construction modes of the approaching lighting system such as high fill, sea reclamation, lake reclamation, and high towers, saving the project investment, reducing operation and maintenance costs, mitigating the risk of high-altitude lights maintenance, and improving the convenience, safety and efficiency of operation, showing significant social, economic, environmental and ecological benefits.

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1. INTRODUCTION

1.1 This paper analyzes the shortcomings of the conventional construction modes of approach lighting system, such as high fill, sea reclamation, lake reclamation, and high towers, etc., and then introduces the Prefabricated ALS Bridge, analyzing the advantages, structural characteristics and main characteristics of this construction mode.

1.2 Comparing with the conventional construction modes, the prefabricated ALS bridge has adequate spanning capacity, reducing the damage to the natural environment by filling and excavating, the small engineering amount with less steel and cable, low engineering cost, and the maintenance of lights is very convenient, which has a very obvious advantage.

2. DISCUSSION

Disadvantages of the Conventional ALS Construction Solutions at Airports

2.1 When a high fill solution is adopted in areas of large topographic relief for the approach lighting system, excavating or backfilling with earth and rock borrowed from other places is essential, which causes general landform and terrain damage furthermore, disrupts the existing terrestrial environment, modifies rainfall runoff patterns or surface water flow, leads to irreparable consequences or damage to the surrounding ecosystem. When implementing the ALS in waterfront airports, conventional solutions in numerous instances have entailed land reclamation (Zhuhai Airport) or lake filling (Wuhan Airport). Such practices potentially change the original hydrological environment, affect aquatic rare species, and even cause irreversible impacts on the natural ecology.

2.2 When a high fill solution is adopted, both excavation and backfilling occupy land, which requires application and approval, and land acquisition is difficult, there are many procedures with long period. Besides, this solution may readily clash with environmental preservation principles and policies. Moreover, the lengthy timeframes associated with scheme validation and reclamation permitting contribute to an elongated project implementation period. The cost of high fill solution is higher, backfilling operations often entail millions of cubic meters of soil, its construction cost usually accounts for more than 80% of the entire project budget.

2.3 Therefore, some airports have optimized the ALS construction modes, and the "single steel tower for each center line or crossbar lights" has replaced the high fill solution.” China has implemented a large number of ALS bridges in this solution in mountainous airports, and the tower height of Yunnan Cangyuan Airport has exceeded 128m. However, this "high tower" solution also has some shortcomings: (1) the increased usage of steel towers, significant steel consumption, and longer cable requirements for lighting fixtures naturally elevated the overall project costs. (2) The follow-up

maintenance of the high tower is very difficult, in the subsequent management and maintenance, leading to a significant escalation in expenses. (3) The ability to cross obstacles is weak, and when the lighting arrangement conflicts with the existing buildings and roads, building relocation and road rerouting are essential.

2.4 When implementing the "Single steel tower for each centre line or crossbar lights" solution, the lighting aids are mounted on frangible mounting devices, which are fixed on top of a tower. During the maintenance and servicing, personnel ascend these towering structures using ladders and then lower the frangible mast for high-altitude maintenance. With the exception of rare emergencies, routine maintenance of these aids is performed on a monthly basis. The act of climbing towers and engaging in high-altitude maintenance presents various safety risks and dangers, resulting in increased maintenance expenses. To address these challenges, there are two solutions: One is to replace the incandescent lamps with LEDs in ALS in order to increase the lifespan, and the other is to install lifts on some of the towers in order to reduce the risk of high-altitude maintenance, which has resulted in enormous investment.

Introduction to the Prefabricated ALS Bridge Solution and Its Advantages

2.5 The prefabricated ALS bridge at mountainous and waterfront airports is a new structure suitable for ALS construction. It replaces the traditional "Single steel tower for each centre line or crossbar lights" structure, supporting all the lights in ALS, with the standard spacing of 30 meters, to the required elevation. It is a stable installation and a convenient maintenance platform for ALS.

2.6 The construction of this kind of bridge is an engineering practice to the concept of "Safe, Green, Smart and Humanity-centered" of "Four Characteristics Airport" in China civil aviation. **For green airport**, it reduces the ecological impact caused by conventional construction modes of high fill, land reclamation, and lake filling in approach lights zones. **For safe airport**, it mitigates the risk of climbing the tower for high-altitude maintenance. **For smart airport**, it adopts BIM technology in digital design. **For humanity-centered airport**, it enhances maintenance convenience during operation.

2.7 The specific contrast data between the new solution and the conventional ones are as follows:

a. Environment-friendly: The prefabricated ALS bridge avoids the occupation of a large amount of land, lake and marine resources by high fill, land reclamation and lake filling projects. Compared with the "Single steel tower for each centre line or crossbar lights" approach, it required fewer towers, resulting in approximately 80% less occupancy. It is environmentally friendly with the minimal damage to the natural environment.

b. Green and energy-saving: The prefabricated bridge saves more than 50% of the steel consumption, saves about 80% of the amount of concrete work for pier foundation, and required much shorter cables for the light units. It reduces the construction cost of the project by 60%, and saves at least about 2 million USD/project for each use. It also reduces carbon emissions by more than 1,000 tons/project.

c. Convenient maintenance of lights: maintenance personnel can reach each light units easily through the maintaining roadway on the bridge. As the "Single steel tower for each centre line or crossbar lights" approach requires certified maintenance personnel's operation on towers, the bridge solution reduces the potential hazards and high maintenance expenses caused by operations high above the ground. It is estimated that the cost for operation and maintenance could be saved at around $20,000 in mountainous areas each year, and more than $30,000 in high plateau areas each year.

d. Great spanning capacity: the bridge span ranges from 60 to 92 meters, capable of crossing mountainous terrains, small rivers, and railways or roads, reducing or avoiding the need for land acquisition and rerouting.

Structural features and Characteristics of Prefabricated ALS Bridge

2.8 Considering the practices requirements for constructing the lighting system of various lengths, the modular design of the bridge deck structure allows for flexible adjustment of the overall length of the superstructure by increasing or decreasing the number of standard segments (span diameter) and the number of piers (spans). This design could meet the demand for ALS. The current bridge superstructure adopts the rectangular trusses. At present, a triangular truss structure with less material consumption and better wind resistance has been proved by calculation, and will be put into practice in the construction of new bridges.

2.9 The scheme for the bridge substructure, including the form of the pier, material, and connection joints, etc., is determined after considering the total load of the superstructure and the capability of crossing obstacles. This ensure the stability and reliability of the supporting system. The bridge could adapt to different height variations through the implementation of piers with a uniform slope-variable cross-section. We have used a 26m-long cantilever structure at Shiyan Wudangshan Airport, effectively circumvented the necessity for rerouting the existing road and minimized the construction of the tallest bridge pier. In next phase, we will continue to reduce the amount of steel used in the piers through detailed calculations, including increasing the bridge span from 92m to approximately 120m. Additionally, we plan to decrease the amount of steel usage and improve wind-resisting performance by using single-column piers that are similar to wind turbines.

2.10 The material for prefabricated bridge piers and bridge deck is selected according to the advantages and disadvantages of different materials (such as steel, including weathering resistant steel, aluminum alloy, and high-performance concrete, etc.), combining with other factors such as strength, weight, durability and economic efficiency. Since 2022, uncoated weathering steel has been widely used in constructing highway bridges (e.g. Shaxi Bridge) in China, and the color of the steel will change over time, gradually transitioning from light yellow to dark brown. The application of uncoated weathering steel significantly reduces the overall lifecycle costs of the project, and it also solves the maintenance problems including painting of conventional steel bridges in the future. In next phase, we will introduce new materials to further increase the lifespan of the bridges in ALS.

2.11 According to different construction circumstance of the airport project worldwide, we adopted different standards in designing, manufacturing and usage of the bridges. Especially the differences in wind loads, ice/snow loads, to meet the different needs for the approach lighting system around the world. We aim to identify, through further analysis, the optimal and most cost-effective bridge span, and share the progress of our work through the Information Circulars with all parties.

3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to:

a) Recognize the advantages, application and main characteristics of the prefabricated ALS bridge at mountainous and waterside airports introduced in this DP; and

b) promote the application of the prefabricated ALS bridge at mountainous and waterfront airports.

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