Process research and comprehensive application of ecological intelligent field section of urban rail transit based on BIM technology

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Abstract: Urban rail transit engineering is a multi-specialty, multi-role complex system engineering under multi-constraints, long period and large investment. BIM technology application has built an open platform for construction, collaborative design and analysis. On the basis of summarizing the current research and application deficiencies, the multi-professional and multi-CAD /CAE software collaboration based on BIM, combined with the modern concept of green, intelligent and coordinated development, adopted new technology and new equipment, carried out innovative research from multiple aspects of intelligence, sponge ecology, energy saving and assembly design. In order to create a modern and intelligent urban rail transit yard process.

Key words: coordinated design; Intelligent; Sponge ecology; Intelligent energy saving and assembly type

At present, the design of urban rail transit vehicle base mainly adopts two-dimensional design, and each specialty carries out the professional design content on the basis of the general plane design of the vehicle base. This method inevitably has many design errors such as elevation direction, underground pipeline collision, foundation fighting, and other kinds of coordination efficiency among specialties is low. Based on the full automatic driving Nahong vehicle base of Nanning Urban rail Transit Line 5, the following BIM innovation design and application are carried out in this paper.

1. Multi-field collaborative design and application based on BIM model

1.1 Intelligent design

(1) Intelligent design of automatic driving check operation management

Automatic driving according to the function of the vehicle base is divided into automatic driving area and non-automatic driving area, automatic driving area mainly includes train inspection shed, car washing shed, dynamic detection shed, throat area and other areas, non-automatic driving area mainly includes maintenance workshop, office buildings, materials warehouse, test line and other areas. Fully automatic vehicles in the open section of OCC and internal scheduling control conversion, vehicles in the no-man's area automatically complete the vehicle wake up, self-test, start, acceleration, deceleration, cruise, idle, parking, returnback and sleep and other functions. Automatic operation conditions have further improved the safety of the vehicle itself, operation and maintenance mode and all kinds of equipment, and provided more process card control and operation procedure management for the personnel who enter the no-man's area. In order to ensure the reliability of the operation in the no-man's area in the vehicle base, Beijing Subway Yanfang Line has increased the duty personnel at the position of the driver's underpass. Register all the personnel who enter the driver's underpass, and the personnel who enter the column inspection zone need to obtain the access key of the corresponding zone here.

Nahong Vehicle Base of Nanning Metro Line 5, based on the existing inspection schemes of other cities in the country, based on BIM model and the maintenance procedures of existing lines, simulated the inspection assembly line of Nahong Vehicle Base, divided the multi-functional team members, inspection and cleaning personnel, and set access control in the warehouse where the drivers enter the inspection section through the underpass. The inspection and sweeping personnel enter the inspection section from the end of the warehouse, and the access control at the end of the warehouse and the operation plan adopt logical interlock control, while the access control at the bottom of the tunnel is bound with the information of the multi-functional team members. Considering that the personnel protection switch needs to be opened when the list inspection and sweeping personnel enter the inspection zone, the position of the personnel protection switch is optimized, and the position of the personnel protection switch is changed from the original position in the library to the end passage of the library. The scheme reduces the empty distance of the maintenance personnel, improves the maintenance efficiency, and reduces the various operators such as task distribution, quality monitoring, access control management and electrical inspection and grounding. The staff can be reduced by 10%-15%, and the effect of "reducing staff, increasing efficiency and ensuring safety" is achieved.

(2) Large frame repair process line design

On the basis of the BIM model of the overhaul warehouse, the simulation of the repair process line of the large shelf was carried out in conjunction with RobotStudio, and the process design of the overhaul warehouse was improved, which not only made mistakes and missed collisions in the original scheme, but also improved the design quality.

1.2 Sponges, ecological design

According to the meteorological data of Nanning and the 100-year flood level value, the sponge ecological vehicle base model was built according to the sponge design concept during the design of Nahong vehicle base. The transfer reservoir was designed in the vehicle base, the drainage system of the vehicle base was simulated by BIM, and the size and shape of the reservoir were optimized for many times according to the 100-year flood level value of Nahong.

The annual average precipitation of Nanning is 1270mm, and the annual rainfall mainly concentrates in June to September, accounting for about 71.2% of the annual rainfall. The average annual evaporation is 1608mm, the measured monthly maximum evaporation is 195.8mm, which occurs in July, and the measured monthly minimum evaporation is 69.9mm, which occurs in February. The summary of various meteorological characteristic values of Nanning meteorological station is shown in Table 1.1.

Table1 Characteristics of Nanning meteorological station

Month of month Items	Units	January	February	March	April	May	June	July	August	September	Oct.	November	December	All year	Adopt series
Multi-year average temperature	℃	12.7	13.8	17.6	22.1	26.0	27.6	28.4	28.0	26.8	23.4	18.6	14.6	21.6	1961-1990
Average evaporation over many years	mm	76.6	69.9	93.6	122.4	174.6	175.1	195.8	179.4	175.9	148.9	107.6	88.8	1607.8	1961-1990, Small evaporating dish
Average rainfall over many years	mm	38.9	44.3	53.9	89.0	191.5	213.1	181.8	196.6	118.2	67.7	46.5	23.8	1265	1951-1993
Maximum daily rainfall	mm	68.7	59.9	68.4	104.5	87.1	145.6	198.6	193.1	160.1	82.6	71.1	59.5	198.6	1961-1990
Average humidity over many years	%	77	81	82	82	80	82	81	82	79	77	76	75	79	1961-1990
Average multi-year wind speed	m/s	1.5	1.7	1.8	1.9	1.9	1.9	2.0	1.6	1.4	1.3	1.2	1.3	1.6	1961-1990
Maximum wind speed	m/s	9.6	12	13.4	12.3	13.9	11.8	16.9	12.4	15.7	16	8.3	7.8	16.9	1964-2004
Maximum wind speed corresponding to the wind direction		NE	WSW	ESE	W	SW	WSW	SSW	ENE	ESE	NW	NNE	NNW	SSW	

The rainwater drainage flow in the vehicle base is calculated according to the rainstorm intensity in Nanning, and the calculation formula is as follows:

$i = 25.788(1 + 0.516\lg P) / (t + 15.293)$ ^ 0.793(mm/ min)

Where P: the design rainstorm recurrence period (year), which is 5 years; t: rainfall duration (min), t=t1+t2; Where t1: ground water collection time (min), calculated by 5min; t2: the rainwater circulation time (min) in the pipeline canal. According to the calculation results, the final design of the storage pond capacity of about 28,000 cubic meters, to meet the demand for rainwater storage and also serve as a landscape lake. Combined with the sponge square, ecological parking lot, sunken green space and rain garden with a total area of 6,986 square meters, the annual runoff control rate of the site can reach 77.47%, and the annual pollutant control rate can reach 57.4%. After collecting and purifying the rainwater in the field section, 63,000 tons of water can be saved every year, and about 47,000 tons of external sewage discharge can be reduced.

1.3 Design of national characteristics

Reflecting the unique regional culture of a region, the elements of local unique architecture can be extracted and used; Architectural groups can be combined with local historical origin to create characteristic regional architecture. Nahong Vehicle Base adopts the concept of green ecological design, adopts BIM technology, and actively integrates the elements of local Zhuang characteristics wind and rain corridor into the design of office and production plant in the section through model optimization design. The building form fully integrates into the surrounding environment, and effectively beautifies the overall image around the section. The landscape, culture and environment in the section are coordinated and unified, effectively improving the comfort of the operation stage.

1.4 Energy saving design

Based on the BIM model, Nahong Vehicle Base adopts skylight on the roof surface of the material depot, the transfer machine and the engineering garage, and adopts light guide tube for the cover plate of the access segment line. The parameters of each production house and the selection of skylight/light guide tube are shown in the following table.

Table2 Parameters of production warehouse and selection of skylight/light guide tube

Name of warehouse	Three-dimensional dimensions (L x W x H)	Space maintenance factor	Space surface reflection coefficient			Daylighting skylight / Light tube	
			Ceiling	Walls	Floor	Selection	Quantity

Inventory of supplies	68300 * 54200 * 13500	0.8	60%	50%	20%	56	56
Shunting and engineering garage	53300 * 30000 * 13500					24	24
Access segment line cover plates	352520 * 60000 * 8500	0.8	50%	50%	20%	56	56

1.5 Prefabricated design

A comprehensive pipe corridor of 1.9km has been built in Nahong Vehicle Base, which has comprehensively improved the working environment of pipeline maintenance and saved the land of the field section. BIM is used in the design process to select and analyze the section, and the most economical and reasonable section type is simulated, saving 1.93 million yuan for the project investment. At the same time, new construction technologies such as prefabricated steel grid roof, prefabricated maintenance operation platform and prefabricated integrated support and hanger are adopted, which significantly reduce the on-site processing work, save labor and material costs, shorten the on-site construction time of about 3 months, and reduce the on-site operation of about 23040 hours.

2. Conclusion

To carry out design innovation from the whole cycle of the project, relying on BIM technology, combined with the adoption of intelligent, information, assembly, energy saving, ecological and other new technologies, the adoption of BIM technology is the key to achieve its high efficiency, standardization, low cost, and comprehensive collaboration. Through the above analysis, the conclusions are as follows:

(1) Based on the BIM model of no-man's land of Nahong Vehicle base, combined with the analysis of fully automatic driving operation scenarios, simulate the operation process of listing inspection, optimize the location of equipment layout, reduce the flying distance of listing inspection personnel, and improve the maintenance efficiency;

(2) Improve the design of the original large frame repair motor and the disassembly and assembly process of the bogie, optimize the process layout of the station, reduce the waste of the site and improve the design quality;

(3) BIM is adopted to simulate the water flow of the reservoir and optimize the shape of the reservoir to create the characteristic building of Nahong Vehicle Base. The annual runoff control rate of Nahong Base can reach 77.47%, and the annual pollutant control rate can reach 57.4%. After collecting and purifying the rainwater in the field section, it can be used in the production and cleaning and greening of the field section, saving 63,000 tons of water per year. Reduce external sewage discharge of about 47,000 tons;

(4) the building form fully integrates into the surrounding environment and effectively beautifies the overall image around the section. The landscape, culture and environment in the section are coordinated and unified, effectively improving the comfort of the operation stage;

(5) Through energy-saving simulation analysis, light guide lighting is set in the cover plate of the access segment line, and the skylight is used in the material storage and hangar, which can save 304,000 kW˙h/ year and save about 220,000 yuan/year in investment;

(6) Using BIM for section selection and analysis, the most economical and reasonable section type is simulated, saving 1.93 million yuan for project investment. At the same time, the assembly design is adopted to shorten the site construction time of about 3 months and reduce the site operation of about 23040 hours.

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