Simulation Analysis of Traction Path in the Context of Next-generation Tractors

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Abstract: In the context of the next generation tractor, design the location of the tractor towing, the tractor's return path, and use simulation technology to simulate and analyze airports with different throughput levels. Based on the analysis of the simulation results, simulation recommendations are given.

1. Background

Based on the current regulations for ground traffic management in the flight area and the existing ground transportation facilities and equipment, the next-generation ground-based system continues to provide aircraft with traction services beyond propulsion by expanding the range of towing vehicles, that is, towing the traction vehicles on taxiways other than the tarmac. To reduce unnecessary work and fuel consumption of aircraft engines on the airport ground.

2. Cogitation of the Research

To study the running path of the tractor in the context of the next generation tractor, firstly design the traction stops of the tractor, and design the return paths for different traction stops, then use simulation technology to build a micro-simulation model, design the simulation scheme, and finally The simulation data is analyzed, and recommendations are given for different airport levels.

3. Research Program

3.1 Simulation modeling background

For airports where there is no parallel taxiway on one runway and one parallel taxiway on one runway, a representative airport with a running and slipping system is selected for research. The main research plan is the plan for the taxiing of the aircraft to the runway end and the rear traction The return schemes for vehicles are designed differently, and typical airport related data is shown in Table 1 below.

Table 1 Typical airport data

Airports	Running&taxiing system	Throughput	Number of tractors in simulation
A	no taxiway on a runway	0.5-1 million	4
B	no taxiway on a runway	0-0.5 million	5
C	one taxiway on a runway	5-10 million	9
D	one taxiway on a runway	1-5 million	12
E	one taxiway on a runway	20-25 million	11

3.2 Simulation model building

According to the tractor operation plan of typical airports designed for each running and sliding system, micro-simulation technology is used to build a large-frame road network for the airport flight zone running and sliding system simulation. The main steps include building the simulated road network, vehicle model construction, path flow input, and expected speed changes Steps of setting, setting parking waiting buffer point, setting time detector, etc.

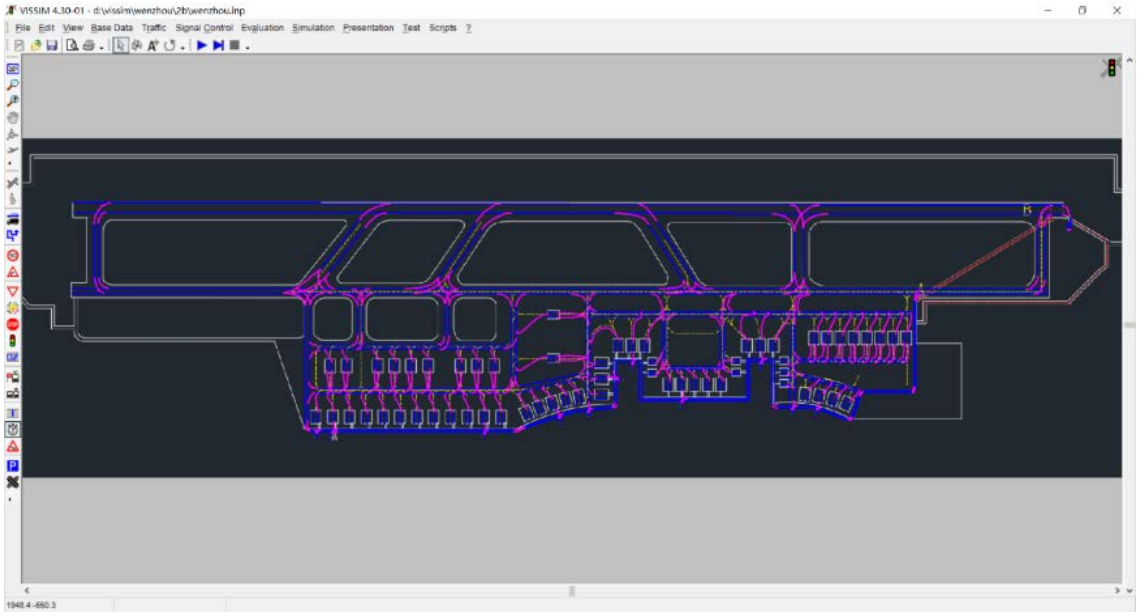

Fig. 1 Road network construction of an airport

3.3 Data analysis of simulation scheme

Taking the typical airport case described in 3.1 as the simulation research object, discuss whether to use a tractor to tow the aircraft and, if using a tractor towing the aircraft, analyze the tractor towing aircraft and the non-towing aircraft to make the aircraft according to the various solutions of different return paths, the output data of required taxi distance and total taxi time from aircraft to runway outset. And then, and comparing the output data of taxi distance and taxi time of the towing vehicle from the aircraft to the parking area. The outputs of the average time of the aircraft according to each airports' parking areas are shown in the following table.

Table 2 Time comparison of taxiing to runway end (s)

Airports	Aircraft self-sliding	Tractor-Near Position	Tractor-Remote
A	373	1110	/
B	416	1368	2207
C	399	1205	846
D	500	1524	1369
E	567	1391	1428

Table 3 Time comparison of towing vehicle to the end of the runway or taxiway (s)

Airports	Taxi from near position to runway end	Taxi from remote to runway end	Taxi from near position to design point	Taxi from remote to design point
C	1205	846	647	337
D	1524	1369	1020	978
E	1391	1428	869	1077

Table 4 Time comparison of tractor's original road return plan (s)

Airports	Runway end to near position	Runway End to remote	Design point to near position	Design point to remote
C	496	451	156	117
D	575	596	271	298
E	550	639	206	299

Table 5 Comparison of the total time of the tractor's original road return plan (s)

Airports	Runway end to near position	Runway End to remote	Design point to near position	Design point to remote
C	1701	1297	803	454
D	2099	1965	1291	1276
E	1941	2067	1075	1376

Table 6 Comparison of tractor return time (s)

Airports	By original road	By patrol Road	By underpass
A	436	192	151
B	533	275	225
C	481	294	202
D	582	434	348
E	607	482	351

4. Program evaluation and summary

In the case of considering whether to use a tractor, evaluate the time index of the following four parts:

(1) Airplane slips to takeoff at runway end & towed to takeoff at runway end:

In the analysis of the time index, it is obvious that the time taken for the aircraft to skid is less, and the aircraft does not need to consider the evaluation of the plan of the tractor returning, so the time index is slightly better.

It is estimated that the time taken for the aircraft to slide to the end of the runway and the tractor towing the aircraft to taxi to the end of the runway is about 1: 3.

(2) The tractor towing airplanes to the end of runway & The tractor towing airplanes to the design point:

Considering the large throughput of some airports, if a tractor is used to tow the aircraft to the end of the runway and then return, it may cause serious airport congestion, and the tractor cannot return in time, and the efficiency of the tractor is not high. The ratio of the time taken by a car to the runway to the original road and the time to return to the boundary between the apron and the taxiway is 2: 1.

(3) Tractor return by original road & Tractor return by patrol road & Tractor return by underpass:

If a tractor is used to tow the aircraft to the end of the runway and then return, for small airports, the return paths of the three solutions are quite different. The patrol road and the underpass are basically directly connected to the apron and close to the terminal. Near the parking area, and in the design of the large-scale airport, in order to consider the cost and other issues, the three solutions differ in that they return to the boundary between the apron and the taxiway, and then rely on the tractor to move along the special equipment on the side of the terminal. When taxiing to the parking

area by the side of the lane, the path when returning from the apron is basically the same, so the difference in the time consumptions is not very obvious. According to the different return schemes designed above, the simulation and comparison are performed in turn.

① "One runway" airport, return by the original road: return by the patrol road: return by the underpass = 10: 4: 3.

② "One runway and one taxiway" airport, return by the original road: return by the patrol road: return by` the underpass = 6: 5: 4.

Because there is no significant gap between the return time of the round road and the return time of the underground passage, combined with the cost analysis of Chapter 3 above, for the " One runway " airport, the airport with a small flight throughput, it is more appropriate to choose the original road return plan; It is more appropriate to choose the road-patterning scheme for airports with the weight of " One runway and multiple taxiway " and above.

(4) Near position & remote

"One runway" airport is basically near the aircraft, so the return of tractors is basically concentrated at the junction. For larger airports, the return location of the tractors is close to the terminal for near aircrafts, and far from the aircraft. There will be a rendezvous point, and the return distance is relatively long. In the comparison and analysis of the plan of using a tractor towing the aircraft to the runway end and returning to the original road, according to the analysis of point 3 above, different airport configurations choose different return plans for total taxi time Contrast:

① The total time for the " One runway " airport return by the original route plan, near position: remote= 2: 3

② The total time for the return plan of the airport patrol road of the order of " One runway and one taxiway ", near position: remote = 1: 1.

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