

Study on the vegetation of New Kitakyushu Airport

[Abstract]

With the aim of investigating the initial state of vegetation after the greening works conducted at New Kitakyushu Airport, which opened in March 2006, and providing basic data for establishing and maintaining green areas, this study surveyed the state of plant growth and evaluated the degree of target achievement.

In the greening works of the airport, suppression of maintenance cost was pursued and vegetation techniques that take into account the gravelly ground of the airport and the environmental situation of the offshore site were adopted. A stepwise formation of green areas was planned in consideration of the vegetation process and the timing of airport opening.

In addition to confirming the achievement level of near-term greening target before the opening of the airport, future evaluation of target achievement based on projected growth of sod after the airport opening was discussed together with maintenance measures. Besides the conventional germination and growth survey, the present strength of grass and the possibility of growth recovery were investigated by laboratory testing.

This study confirmed that the near-term target of creating green areas by the time of airport opening was achieved in a limited period (start of work in the fall of 2005 and start of use in the spring of 2006) by using a fast-growing, cool-season grass. To achieve the eventual target of creating green areas covered with short prostrate grasses, areas requiring protection and maintenance (such as mowing) after the spring of 2006 were identified and specific measures proposed.

1. Study items

The study items are listed below and the study flow is shown in Figure 1-1.

[Planning]

- <1> Grasping of site condition
- <2> On-site investigation

[Survey]

- <3> Growth survey
- <4> Sod bed survey
- <5> Mixed-seeding germination survey
- <6> Sod rooting survey
- <7> Germination possibility survey

[Evaluation]

- <8> Evaluation of greening target achievement
- <9> Future measures

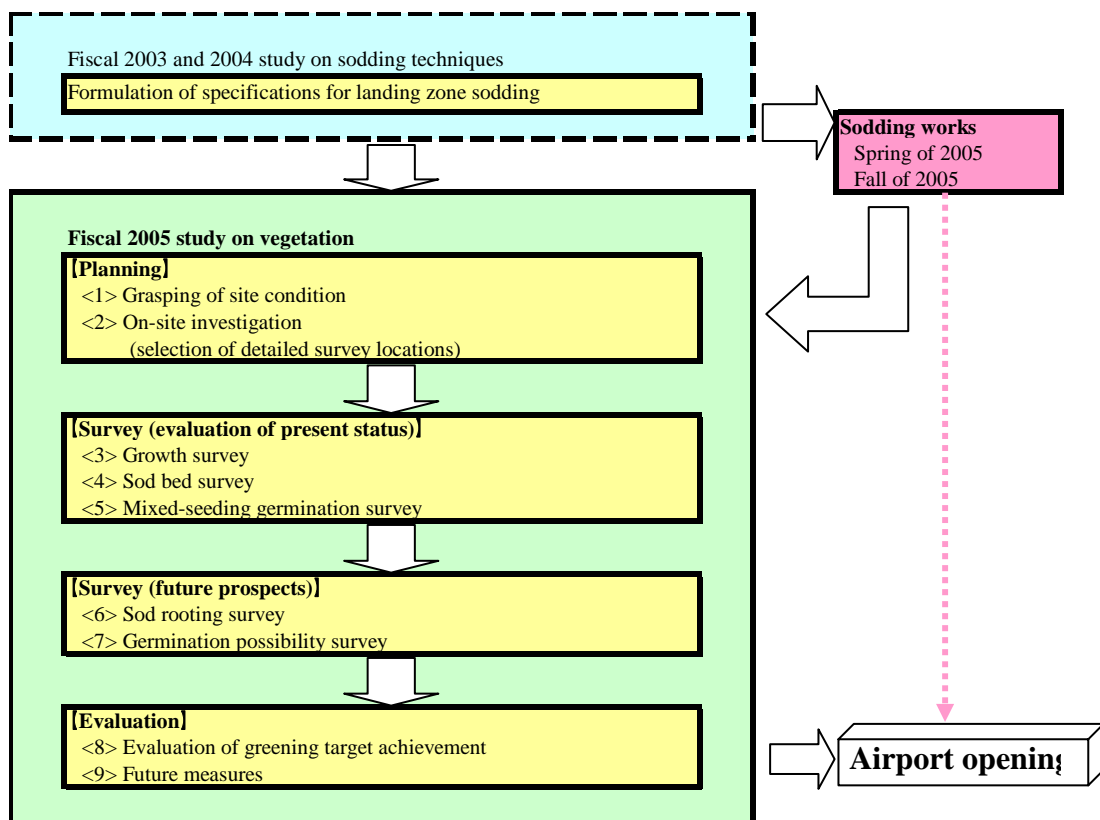


Figure 1-1 Flow of study

2. Study method

This study investigated the growth of sod until the time of airport opening in March 2006, evaluated the degree of greening target achievement, and discussed measures to be taken where necessary.

[Planning]

<1> Grasping of site condition

Relevant data (work record, materials data, completion photos, repair record, meteorological data, etc.) were collected and organized for each vegetation area. The situations of bed preparation and vegetation were investigated and summarized.

<2> On-site investigation (selection of detailed survey locations)

The survey areas were investigated to grasp the entire state of airport vegetation, select survey items and locations, and decide the policy of the survey.

Survey (evaluation of present status)

<3> Growth survey

In the spring and fall seeding areas, the overall state of sod growth was investigated in terms of visual appearance, covering ratio, grass height, and rooting

<4> Sod bed survey

Representative survey areas were selected, the physical properties of the sod bed were measured, and soil samples were collected for laboratory chemical analyses. The condition of the sod bed was thus investigated.

<5> Mixed-seeding germination survey

The numbers of germinated seeds were counted in the fall seeding areas and compared with target values.

[Survey (future prospects)]

<6> Sod rooting survey

The resistance of sods against airplane blasts was investigated by wind-resistance and root strength tests.

<7> Germination possibility survey

In the poor growth areas within the fall seeding areas, the potential of germination of ungerminated seeds remained in the sod bed was investigated by a laboratory test.

[Evaluation]

<8> Evaluation of greening target achievement

Based on the study results, the degree of greening target achievement at the time of airport opening was evaluated and indicators for future maintenance were discussed.

<9> Future measures

Issues to be addressed for establishing and maintaining vegetation in the landing zone were identified and measures to be taken were proposed.

3. Study results

<1> Grasping of site condition and

<2> On-site investigation (selection of detailed survey locations)

The policy of the study, including study areas and items, was decided on the basis of on-site investigation. Sod covering ratios were found to be generally low with some areal variation. A total of 17 locations representing good and poor growth areas were selected from the vegetation areas.

<3> Growth survey

The overall covering ratio was as low as 35% in January 2006 but generally increased in the March survey (end of February). However, covering ratio did not increase substantially in the H survey area, which was subjected to wave overtopping. Additional seeding is therefore required in this area. Successful growth was observed in the P and Q areas, which were partly worked on in the spring of 2005.

* The March survey results are based on overall visual observation.

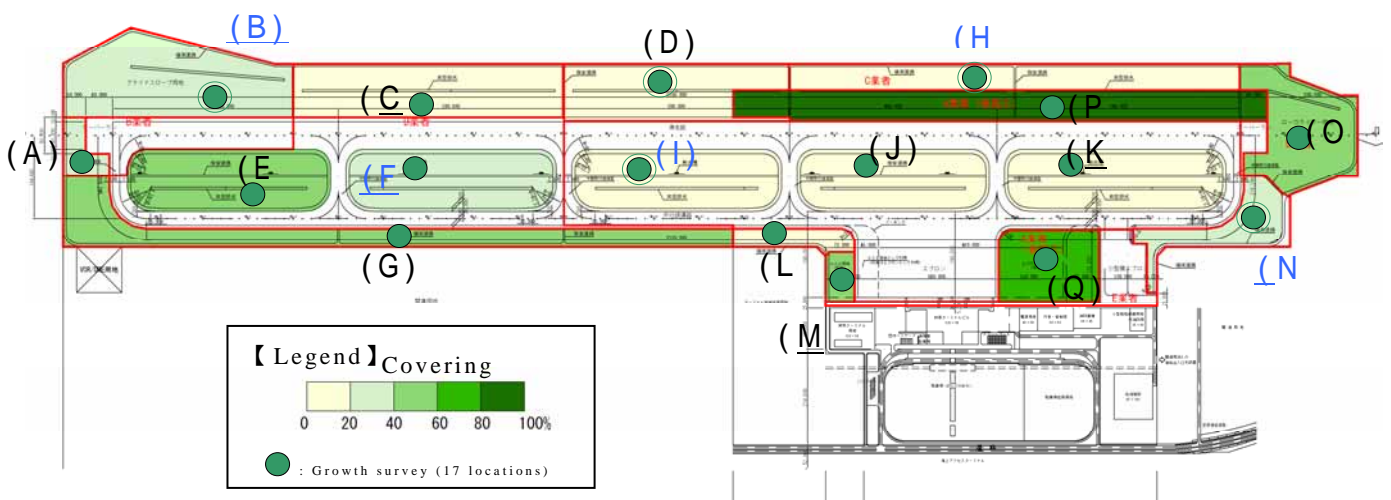


Figure 3-1 Results of covering ratio survey in the entire landing zone

<4> Sod bed survey

The sod bed in the landing zone was found to be small in effective soil thickness, high in soil hardness, and high in gravel content. The bed was thus evaluated as rather unsuitable for vegetation. These findings suggest the problems of (1) restriction of rooting and (2) poor retention of water and fertilizer. Therefore, the growth of vegetation may be susceptible to meteorological variation (such as dryness).

The results of the laboratory test indicate that the soil is low in effective water content and high in solid phase ratio (physical properties); and high in pH, low in fertilizer retentively, low in humus content, and low in nitrogen content (fertility properties).

<5> Mixed-seeding germination survey

The plant density required for the airport (3,000plants/m²) was satisfied in all the vegetation areas. The weighted mean density of the survey areas was 10,000plants/m², whereas the density of each area varied from 3,000 to 25,000plants/m². The low densities observed are probably associated with the washout of seeds together with soil by a rainfall right after the seeding. Most of the plants observed in the fall seeding areas were tall fescue, which is a cool-season turf grass, whereas Bermuda grass was hardly found.

<6> Sod rooting survey

Because the airport will be used mainly by small and intermediate airplanes, discussions were made by postulating an intermediate plane (AB6), whose blast would be most influential. The concerned states of airplane include idling, breakaway, and takeoff; the latter exerts the greatest effect. Because the area directly affected by takeoff (vegetation area at the end of the runway) would be more than 150 m (161 m) distant from the engines, the wind speed of the blast that would affect the sod was assumed to be 22 m/s (50 mph), which corresponds to the wind speed at the time of breakaway.

1) Blower performance test

Table3-1 Results of blower performance test

The results of a blower performance test without background wind indicate that wind speed exceeding 22 m/s is obtained within 3 m from the blower. However, this level of wind speed is obtained only within a radius of 50cm from the center.

Distance from blower	Wind speed (m/s)	
	Center of blower	Below blower
0m	31.9	0.5
1m	32.2	1.0
2m	31.5	4.5
3m	27.5	12.0
4m	21.0	12.5
5m	18.4	12.0

2) Wind-resistance test of sod

In the wind-resistance test, a wind speed of 22 m/s was obtained at the survey location and no sod was removed from the bed. Moreover, no substantial effect of the blast was observed. The root strength surveyed at the same location was in the range between 24 and 35 MPa/m². The test results indicate that the sod is resistant to wind speed up to 22 m/s when the root strength of the sod exceeds 24 MPa/m².

3) Overall survey

Root strength of 24 MPa/m² or more was observed at 44 locations (95%) out of the 46 survey locations. Although root strength was rather low (22 MPa/m²) at the other two locations, the sod was not substantially affected by the blast, as indicated by the wind-resistance test.

The test results indicate that, under the present sod condition (root taking is low and soil is rather wet), the sod will not be removed from the soil when wind speed remains below 22 m/s. It is thus judged that no special measures against blasts are required for the sod at the time of airport opening.

<7> Germination possibility survey

1) Percentage of ungerminated seeds

In the poor growth areas, the soil was bare and seeds were not remained in the soil.

Even in the good growth areas, where vegetation was present and the ratio of bare soil was low, the percentage of ungerminated seeds relative to the initially sown seeds ranged from 30% to 50% for Bermuda grass. Therefore, there was a concern that the germination and growth of the warm-season grass might be suppressed even after the spring season.

2) Laboratory germination test

The seeds in the soil of the poor growth areas germinated and grew in the laboratory at appropriate temperature. Therefore, the poor growth is unlikely to be caused by the soil or seeds themselves.

At appropriate temperature (22 deg C on average) in the laboratory, 28% to 90% of the germinated seeds were Bermuda grass, a warm-season grass. Although tall fescue, a cool-season grass, was dominant at the time of the spring survey, Bermuda grass, which is supposed to be the main grass, is likely to germinate and grow as average temperature rises during the period from spring to summer.

<8> Evaluation of greening target achievement

Unconventional evaluation methods were discussed in view of satisfying the following requirements:

- (1) Achievement of the near-term greening target for airport opening in March 2006 and
- (2) Smooth transition to the future greening target.

As for (1), the "Guide for performance judgment after seeding: grassland" in the "Highway Earthworks Series - Manual for Slope Protection" suggests target covering ratios of 70% to 80% as a guide. In the 2004 Conference for Discussing Vegetation Techniques for New Kitakyushu Airport, however, a minimally required level of vegetation was discussed and a covering ratio of about 60% at the time of airport opening was set as a target.

For the above requirement (2), evaluation was made in consideration of the results of the soil analyses and the germination possibility survey.

1) Achievement level of near-term greening target (at the time of airport opening)

The covering ratio of the entire airport greening areas, including the fall seeding areas, was generally low at 35% in January 2006. Some areas showed high ratios up to 60% but many areas showed low ratios of about 20%. The areas of low covering ratio were classified into two groups: areas where growth can be expected from the spring to summer of 2006; and areas where recovery cannot be expected. Whereas a trend of increase in covering ratio was observed in the former areas in the March survey, seeds were washed out so that countermeasures are required in the latter areas.

The average density of germinated seeds in the entire airport greening areas is 10,000plants/m², which far exceeds the required value of 3,000plants/m². The density, however, varies from 3,000 to 25,000plants/m², which may be explained by the washout of surface soil by the rainfall after the seeding and the resulting inhomogeneity in seed distribution.

Under the present sod condition (root taking is low and soil is rather wet), the sod is sufficiently resistant to the expected blast (22 m/s or less in wind speed) and no special measures are required. This judgment, however, depends on an assumption that root taking will proceed successfully.

2) Discussion on the future greening target

It is possible that the seeds in the poor growth areas germinate as the environmental condition (mainly temperature) become favorable. Because 28% to 90% of the seeds germinated under the laboratory condition were Bermuda grass seeds, the warm-season grass is likely to become dominant as average temperature rises during the period from spring to summer. Because the percentage of ungerminated seeds relative to the initially sown seeds was as low as about 30% to 50% and the total number of germinated seeds was small, additional seeding may be required according to the circumstances.

Although the bed soil was improved by adding soil conditioners (such as bark fertilizer) to the original soil, improvement targets were not satisfied in some items such as humus content, fertilizer retentively, water retentively, and physical properties (soil hardness and solid phase ratio). This is partly explained by insufficient humification of the bark fertilizer, and improvement is expected as decomposition and humification proceed gradually. In the gravelly consolidated areas, however, the bark fertilizer remained in the surface soil and was subjected to washout by rainfall, which led to inhomogeneous distribution. Therefore, soil improvement measures should also be discussed together with additional seeding and other measures.

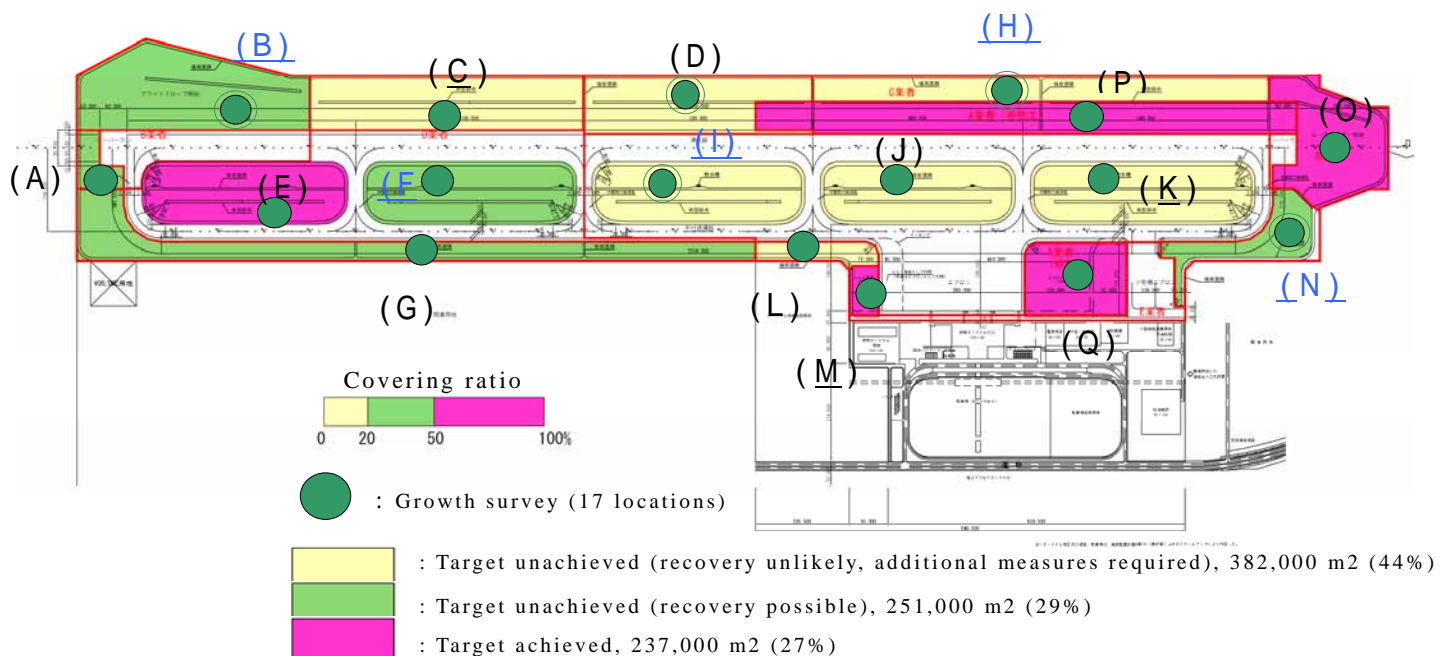


Figure 3-2 Degree of greening target achievement

(2) Future measures

A future target of airport greening is to realize transition of dominant turf grass from tall fescue to Bermuda grass during the period from the spring to summer of 2006. After the opening of the airport, transition to the warm-season grass should be pursued while maintaining vegetation, which requires creation and maintenance of plots, covered with short and dense grasses. The greening targets after the opening of the airport were set to 80% in covering ratio and about 15 cm or less in grass height.

With the aim of establishing and maintaining vegetation in the landing zone, six issues were identified as future challenges.

<1> Achievement of a target covering ratio of 80% in the landing zone: monitoring, discussion on measures to be taken, and confirmative survey after taking measures

<2> Transition to the warm-season grass: mowing, monitoring, and discussion on optimum management methods

<3> Root taking of sod and achievement of the target covering ratio in the landing zone: monitoring, discussion on measures to be taken, and confirmative survey after taking measures

<4> Measures against salt damage (wave overtopping) in the coastal areas of the landing zone: monitoring, discussion on measures to be taken, and confirmative survey after taking measures

<5> Consideration of optimum maintenance methods (weeding and treatment): experience survey and feasibility study

<6> Consideration of scenery viewed from the terminal: discussion on scenery, discussion on measures to be taken, and confirmative survey after taking measures