

## Analysis of Helicopter Landing Pad Planning in the Nagreg Area

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### ABSTRACT

#### KEYWORDS

*Air transportation;  
Heliport; Road  
congestion*

Road congestion along the Cileunyi–Nagreg corridor in West Java intensifies annually during the Eid homecoming period, yet the development of a heliport as an alternative solution remains underexplored. This study examines the urgency of heliport development in Nagreg and calculates the structural dimensions of its concrete slab system, including beam dimensions, slab thickness, and reinforcement requirements. Structural analysis was performed to determine internal forces and load redistribution under dead loads, live loads, and earthquake loads. Beam and slab elements were designed to ensure structural strength and stability, with reinforcement calculated based on the ratio of steel area to concrete area. The beam dimensions were determined as 200/400 mm in the x-direction and 203.75/407.5 mm in the y-direction. The concrete slab thickness was calculated to be 12 cm and reinforced with Ø12 mm bars at 120 mm spacing. Strength verification of the slab confirmed that the nominal moment capacity ( $M_n = 11.436$  kNm) exceeds the required ultimate moment ( $M_u = 5.529$  kNm), thereby confirming structural safety and compliance with applicable standards. The study concludes that heliport construction in Nagreg is technically feasible and structurally viable, offering a strategic alternative to mitigate recurring congestion. These findings provide a foundational technical framework for heliport development in similarly congested corridors. Further research is recommended to assess economic feasibility, environmental impact, and integration with regional transportation master plans.

### INTRODUCTION

An airport is a facility where aircraft take off and land. The simplest airports have at least one runway, while large airports are typically equipped with various additional facilities to serve both flight operators and passengers. According to ICAO (International Civil Aviation Organization), an airport is a designated area of land or water (including buildings, installations, and equipment) intended, either wholly or partially, for the arrival, departure, and movement of aircraft. According to PT (Persero) Angkasa Pura, an airport is an airfield, including buildings and equipment that meet the minimum requirements to ensure the availability of air transportation services for the community. The primary function of an airport is to serve as a mass transportation facility for passengers and goods (Cao et al., 2023; Pivac et al., 2025; Pivac & Bartulović, 2026).

The objective of Sistranas (National Transportation System) is to realize an effective and efficient transportation system that supports and stimulates development dynamics, enhances the mobility of people, goods, and services, promotes stable and dynamic national distribution patterns, supports regional development, and strengthens national unity within the framework of the archipelagic outlook, while also enhancing international relations (Dephub).

An airplane is a heavier-than-air aircraft with fixed wings that can fly using its own power (Rajam et al., 2023; Uppu, 2022). It is any device capable of flight in the atmosphere due to aerodynamic lift generated by air reactions (Anish et al., 2026; Araghizadeh et al., 2025; Piotrowski et al., 2024).

A heliport is a small airport specifically designed for helicopters. Heliports usually consist of one or more helipads (Andrade et al., 2022; Camino Julibert, 2024; Putra et al., 2024). A helipad is a designated landing and takeoff area for helicopters. Due to the helicopter's ability to take off and land vertically, a helipad requires relatively limited space and may be located in various places, provided sufficient clearance exists for rotor operations. Helipads are commonly found on building rooftops, hospitals, offshore platforms, or naval vessels. For visibility from the air, helipads are typically marked with a circle containing the letter "H" in the center or simply a large "H."

A helicopter is an aircraft that derives lift from the rotational motion of its rotor blades (Robert Horonjeff and Francis X. McKelvey). Helicopters are versatile modes of transportation due to their operational flexibility (Kumar, 2024; Wróblewski et al., 2024; Yıldız et al., 2025). Compared to airports for fixed-wing aircraft, helicopter facilities generally require smaller areas. Helicopters are capable of providing a wide range of services and can be integrated into local transportation systems (Aircraft Fuel Storage).

The standard helicopter takeoff procedure begins with a vertical ascent assisted by ground effect, which is created by air pressure directed downward by the rotating blades. After ascending vertically approximately 5 to 10 feet, forward motion begins until climb speed is reached (approximately 30 to 50 knots). Before achieving climb speed, the helicopter may either move horizontally or continue ascending. Climb and descent speeds typically range from 30 to 60 knots.

Helicopters provide diverse services to communities and can be integrated effectively into local transportation systems. Their service functions extend beyond passenger transport. First, in disaster management, helicopters are critical when land transportation systems are disrupted. They can transport supplies and response teams and evacuate injured individuals during emergency situations. Second, in air ambulance services, helicopters offer rapid medical transport without being hindered by ground traffic congestion. Third, in maintaining public order, many municipalities rely on helicopters for surveillance and law enforcement support. Media outlets such as newspapers, radio, and television stations also use helicopters for aerial news coverage and traffic reporting.

Heliport facilities can function as strategic transportation infrastructure. Although currently associated with specialized or high-income users, heliport utilization may expand in the future to serve broader public needs. Effective heliport planning requires careful consideration of location, accessibility, demand potential, airspace protection, and compatibility with surrounding land use. Optimal heliport placement typically corresponds to industrial, commercial, and business activity centers, which generate demand for helicopter services. Additionally, heliport placement must ensure relatively unobstructed airspace to enhance operational safety and prevent airspace conflicts.

Air transportation plays a critical role in meeting human mobility needs, primarily due to its travel time efficiency compared to other transportation modes. Similarly, helicopter

transportation offers high time efficiency and operational flexibility, making it a viable alternative in congested areas.

Several previous studies have examined transportation infrastructure solutions to address congestion. Basuki (2008) emphasized integrated transportation planning that combines multiple modes to create efficient and reliable systems. Bhanot (1989) discussed the role of airports in regional development and their potential to reduce pressure on overburdened land transportation networks. Horonjeff and McKelvey (1983) provided comprehensive guidelines on heliport planning and design, highlighting the strategic value of helicopter facilities in urban and regional transportation systems. Internationally, helicopter transportation has been integrated into mobility networks in cities such as São Paulo, New York, and Tokyo, where heliports function as critical nodes for time-sensitive passenger movement and emergency services.

Despite these contributions, research specifically addressing heliport development in Indonesia as a solution to seasonal road congestion remains extremely limited. Most existing studies focus on fixed-wing airport planning, while heliport development—particularly in the context of mitigating congestion during homecoming (*mudik*) seasons—has received minimal scholarly attention. Furthermore, no previous study has conducted detailed structural analysis for heliport concrete slab design in specific high-congestion corridors such as Nagreg. This gap is significant given the recurring nature of congestion in the Cileunyi–Nagreg corridor and the absence of sustainable, long-term solutions.

This study provides a novel contribution by examining the feasibility and technical planning of a heliport in the Nagreg area as an alternative transportation solution to bypass road congestion. The novelty lies in integrating transportation needs analysis with structural engineering calculations for heliport concrete slab design, resulting in a practical and implementable technical framework. The objectives of this study are: (1) to analyze the urgency of heliport development in Nagreg based on congestion patterns and transportation demand; (2) to calculate the structural dimensions of the heliport concrete slab, including beam diameter, slab thickness, and reinforcement requirements; and (3) to produce a technical planning document that may serve as a reference for future development.

Considering the recurring need for air transit facilities, particularly during the Eid travel season in the Cileunyi–Nagreg corridor, establishing a heliport in the Nagreg area is considered necessary. This final project focuses specifically on the planning of the helicopter field slab structure in Nagreg. Entitled *Analysis of Helicopter Field Slab Planning in the Nagreg Area*, this study aims to generate numerical design values for beam dimensions, slab thickness, and reinforcement diameter. The calculations are intended to provide technical guidance and planning input for heliport development.

The benefits of this research are threefold. Theoretically, it contributes to the body of knowledge on heliport planning and design within the Indonesian context, addressing a previously underexplored area. Practically, the structural calculations and design recommendations offer actionable guidance for government agencies and transportation planners considering heliport development in congested corridors. For future researchers, this study opens pathways for more comprehensive investigations, including economic feasibility analysis, environmental impact assessment, and integration with regional transportation master plans. By addressing both transportation demand and structural engineering aspects, this

research presents a holistic approach to heliport development as a strategic solution to Indonesia's persistent congestion challenges.

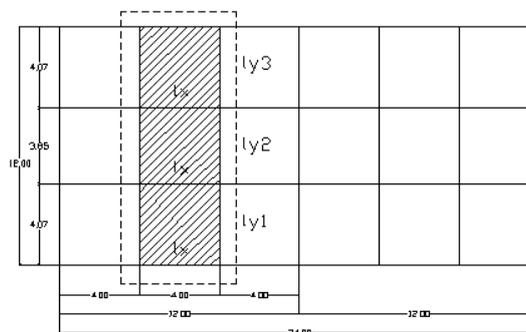
## METHOD

Structural analysis aims to calculate the internal forces, positioning reactions, and load shifts, which include dead loads, live loads, and earthquake loads. The loads include the self-weight of columns, beams, walls, floor plates, as well as loads from ceilings and installations. The live load is calculated based on the use of the building, which includes space fixtures according to the use of the floor and other loads, with special attention to roof and floor loads. Earthquake loads are calculated using the spectrum response method, taking into account earthquake factors based on region, building type, and building structure.

The calculation of structural elements such as columns and beams is carried out to ensure strength and stability, taking into account bending and axial loads. For columns, centric and uniaxial load analysis is performed to determine the load capacity and moment, as well as tensile or compressive collapse analysis. On plates, calculations are made taking into account the appropriate concentration, theoretical span, and thickness of the plate. The required reinforcement is determined based on the ratio between the cross-sectional area of the steel reinforcement with the effective area of the cross-section, to ensure the capacity of the structure in withstanding the accepted load.

## RESULT AND DISCUSSION

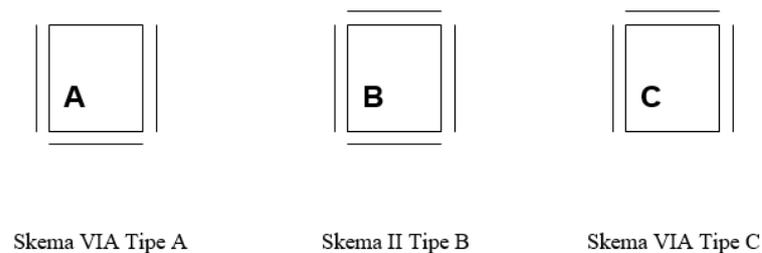
### Block Planning



**Figure 1. Heliport Concrete Slab Planning Plan**

Plate A and plate C are considered partially pinched, hence the scheme taken in the moment table of the envelope method is the VIA scheme.

For plate B is considered to be fully clamped, then the scheme taken in the moment table of the envelope method is scheme II.



**Figure 2. Type A, Type B and Type C Schemes**

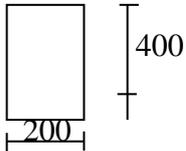
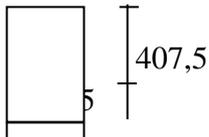
#### 4.1.1 Estimating the Height of the Beam

- X-direction beam with span 4000 mm
  - $h = 1/10 \times \text{span}$
  - $= 1/10 \times 4000$
  - $= 400 \text{ mm}$
- The y-direction beam is taken the longest span with a span of 4075 m
  - $h = 1/10 \times \text{span}$
  - $= 1/10 \times 4075$
  - $= 407.5 \text{ mm}$

#### 4.1.2 Estimating the Beam Width

- Beam direction x with  $h = 400 \text{ mm}$ 
  - $b = 1/2 \cdot h$
  - $= 1/2 \cdot 400 \text{ mm}$
  - $= 200 \text{ mm}$
- Y-direction beam with  $h = 407.5 \text{ mm}$ 
  - $b = 1/2 \cdot h$
  - $= 1/2 \cdot 407.5 \text{ mm}$
  - $= 203.75 \text{ mm}$
- So the size of the directional beam – x is  $\rightarrow 200/400 \text{ mm}$
- So the beam size of the direction – y is  $\rightarrow 203.75/407.5 \text{ mm}$

#### 4.1.3 Plate Beam Cross-Section Picture

- a. Direction Beam x
 
- b. Direction Beam and
 

### 4.2 Plate planning

#### 4.2.1 Determining the Focus and Presentation Conditions

##### a. Partially clamped beams

It can be known the distance of the net span (  $l_n$  ).

- Direction  $L_x = 4000 \text{ mm}$ 
  - Then  $l_n = 4000 - 2 ( 1/2 ) ( 203.75 \text{ mm} = \text{width of the beam direction } y )$
  - $= 3796.25 \text{ mm}$

- Ly1 Direction = 4075 mm  
And then there is the  $= 4075 - 1 ( 1/2) (200 \text{ mm} = \text{width of beam direction x})$   
 $= 3975 \text{ mm}$
- Direction Lx = 4000 mm  
Then ln =  $4000 - 2 ( 1/2) (203.75 \text{ mm} = \text{width of the beam direction y})$   
 $= 3796.25 \text{ mm}$
- Ly3 Direction = 4075 mm  
And then there is the  $= 4075 - 1 ( 1/2) (200 \text{ mm} = \text{width of beam direction x})$   
 $= 3975 \text{ mm}$

**b. Full clamped beam**

It can be known the distance of the net span ( ln ).

- Direction Lx = 4000 mm  
Then ln =  $4000 - 2 ( 1/2) (203.75 \text{ mm} = \text{width of the beam direction y})$   
 $= 3796.25 \text{ mm}$
- Ly2 Direction = 4000 mm  
And then there is the  $= 3850 - 2 ( 1/2) (200 \text{ mm} = \text{beam width of direction x})$   
 $= 3650 \text{ mm}$
- Then for Type A roof plates  
 $ly1/lx = 3975/3796.25$   
 $= 1.05$
- Then for Type B roof plates  
 $ly2/lx = 3796.25/3650$   
 $= 1.04$
- Then for Type C roof plates  
 $ly3/lx = 3975/3796.25$   
 $= 1.05$

**Table 1. List Counting Moments and Choosing Reinforcement**

Direction of the moment	Koef(x)	Mu	$\phi$ Mn	$\rho$	$\rho$ min	As (mm) <sup>2</sup>	Tulangan
<b>Plate A VIA Scheme</b>							
<b>Mlx</b>	0,0277	5,529	4,607	0,0002	0,0035	329	$\phi$ 12 – 120 = 339,3 <i>mm<sup>2</sup></i>
<b>Mly</b>	0,0277	5,529	4,607	0,000171	0,0035	287	$\phi$ 12 – 120 = 339,3 <i>mm<sup>2</sup></i>
<b>Mtx</b>	0,0585	11,676	9,730	0,000276	0,0035	329	$\phi$ 12 – 120 = 339,3 <i>mm<sup>2</sup></i>
<b>Mty</b>	0,0622	12,415	10,346	0,00038	0,0035	287	$\phi$ 12 – 120 = 339,3 <i>mm<sup>2</sup></i>
<b>Plate B Scheme II</b>							
<b>Mlx</b>	0,0268	4,945	4,121	0,000116	0,0035	329	$\phi$ 12 – 120 = 339,3 <i>mm<sup>2</sup></i>

Direction of the moment	Koef(x)	Mu	$\phi$ Mn	$\rho$	$\rho$ min	As (mm) <sup>2</sup>	Tulangan
Mly	0,0244	4,502	3,752	0,000074	0,0035	329	$\phi$ 12 – 120 = 339,3 mm <sup>2</sup>
Mtx	0,0534	9,853	8,211	0,000232	0,0035	329	$\phi$ 12 – 120 = 339,3 mm <sup>2</sup>
Mty	0,0516	9,521	7,934	0,0003	0,0035	287	$\phi$ 12 – 120 = 339,3 mm <sup>2</sup>
<b>Plate C Scheme VIA</b>							
Mlx	0,0277	5,529	4,607	0,0001305	0,0035	329	$\phi$ 12 – 120 = 339,3 mm <sup>2</sup>
Mly	0,0277	5,529	4,607	0,000171	0,0035	287	$\phi$ 12 – 120 = 339,3 mm <sup>2</sup>
Mtx	0,0585	11,676	9,730	0,000276	0,0035	329	$\phi$ 12 – 120 = 339,3 mm <sup>2</sup>
Mty	0,0522	10,419	8,682	0,000323	0,0035	287	$\phi$ 12 – 120 = 339,3 mm <sup>2</sup>

The height of the beam is calculated from the results of the analysis of 1/10 to 1/16 times the width of the beam span (*Reinforced Concrete Planning*). The width of the beam is half the height of the beam. It can be seen that the diameter of the beam in the direction x is 200/400 and the direction of y is 203.75/407.5.

Calculating the conditions of focus and span, it can be known that the distance of the net span (ln) = the span of the beam – 2 . (1/2) . (x directional beam width or y-directional beam width).

Direction Lx = 4000 mm

Then ln = 4000 - 2 ( 1/2 ) (203.75 mm = beam width of direction y)  
= 3796,25 mm

Ly1 Direction = 4075 mm

And then there is the = 4075 - 1 ( 1/2 ) (200 mm = width of beam direction x)  
= 3975 mm

The next step is to calculate the thickness of the slab, fy is assumed to be 400 MPa (*Reinforced Concrete Planning*). According to SKSNI, the thickness of the plate should not be less than

$$h_{\min} = \frac{\ln \left( 0.8 + \frac{f_y}{1500} \right)}{36 + 9\beta}$$

And it doesn't need to be more than:

$$h_{\max} = \frac{\ln \left( 0.8 + \frac{f_y}{1500} \right)}{36}$$

- For Type A plates

With : ln (net span) = 3975 mm

$$\beta = \text{Longest net span} / \text{Shortest net span}$$

$$\beta = 3975/3796,25$$

$$\beta = 1,05$$

So h can be known:

$$h_{\min} = \frac{3975(0,8 + 400/1500)}{36 + 9(1,05)}$$

$$h_{\min} = 9.29 \text{ cm}$$

And it doesn't need to be more than:

$$h_{\max} = \frac{\ln(0.8 + fy/1500)}{36}$$

$$h_{\max} = \frac{3975(0,8 + 400/1500)}{36}$$

$$h_{\max} = 11.78 \text{ cm}$$

Thus, the thickness of the plate was  $9.29 \leq h \leq 11.78 \text{ cm}$

So in the planning of plate A, the thickness of plate  $h = 12 \text{ cm}$  is taken

In the calculation planning of plate B and plate C, it can be known that the thickness of plate  $h = 10.8$  and  $11.78 \text{ cm} \sim 12 \text{ cm}$ .

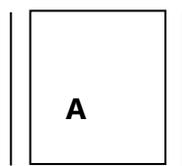
Then calculate the working loads  $W_u = 1.2 \text{ WD} + 1.6 \text{ WL}$ , the load is the dead load and the live load. The dead load consists of its own weight, the weight of the asphalt layer, the weight of sand, the weight of the rainwater puddle. The living load is the weight of a helicopter.

Determining the decisive moments determining type A plates.

The moments are determined according to table 14

At  $l_y/l_x = 1.05$

For the VIA scheme, interpolation is carried out:



$$X_1 = \frac{1,05 - 1,0}{1,2 - 1,0} (36 - 25) + 25$$

$$= 27,75$$

$$X_2 = 27.75$$

$$X_3 = 58.5$$

$$X_4 = 62.25$$

$$M_{lx} = 0,001 \cdot W_u \cdot l_x^2 \cdot X_1 = 0,0277 \cdot 13,85 \cdot (3,79625)^2 = 5,529 \text{ kNm}$$

$$M_{ly} = 0,001 \cdot W_u \cdot l_x^2 \cdot X_2 = 0,0277 \cdot 13,85 \cdot (3,79625)^2 = 5,529 \text{ kNm}$$

$$M_{tx} = 0,001 \cdot W_u \cdot l_x^2 \cdot X_3 = 0,0585 \cdot 13,85 \cdot (3,79625)^2 = 11,676 \text{ kNm}$$

$$M_{ty} = 0,001 \cdot W_u \cdot l_x^2 \cdot X_4 = 0,0622 \cdot 13,85 \cdot (3,79625)^2 = 12,415 \text{ kNm}$$

For type C plates, the same scheme is carried out, namely the VIA scheme, but for type B plates it refers to scheme II.

In reinforcement planning, it is known that the thickness of the slab is 120 mm or 12 cm, Concrete blanket  $P = 20 \text{ mm}$  (table 3, reinforced concrete planning).  $\emptyset$  the reinforcement of the tree is estimated in the direction  $X = \emptyset 12 \text{ mm}$  and the direction  $Y = \emptyset 12 \text{ mm}$ .

- The effective height d in the direction - X is

$$\begin{aligned} dx &= \text{Thickness of slab} - \text{concrete blanket} - \frac{1}{2} \cdot \emptyset \text{ Tree reinforcement} \\ &= 120 - 20 - \left( \frac{1}{2} \cdot 12 \right) = 94 \text{ mm} \end{aligned}$$

- The effective height d in the Y direction is

$$\begin{aligned} dy &= \text{Thickness of the slab} - \text{concrete decking} - \emptyset \text{ Right. Stuttgart} \frac{1}{2} \\ &\cdot \emptyset \text{ Tree reinforcement} \\ &= 120 - 20 - 12 - \left( \frac{1}{2} \cdot 12 \right) = 82 \text{ mm} \end{aligned}$$

Calculating the reinforcement of type A plate, field moment in the direction of

x :

$$Mu = 5,529 \text{ kNm}$$

$$Mn = \frac{Mu}{\phi} = \frac{5,529}{1,2} = 4,607 \text{ kNm} = 460700 \text{ Nmm}$$

$$dx = 120 - 20 - \frac{1}{2} \cdot 12 = 94 \text{ mm}$$

Requirements for field moments

$$\rho_{\min} < \rho_{\text{perlu}} < \rho_{\text{maks}}$$

$$\rho_{\min} = \frac{1,4}{fy} = \frac{1,4}{400} = 0,0035 \Rightarrow \text{for plates}$$

$$\begin{aligned} \rho_b &= \frac{0,85 \cdot \beta_1 \cdot fc}{fy} \left( \frac{600}{600 + fy} \right) \\ &= \frac{0,85 \cdot 1,05 \cdot 25}{400} \left( \frac{600}{600 + 400} \right) = 0.03346875 \end{aligned}$$

$$\rho_{\text{maks}} = 0,75 \cdot \rho_{\text{balance}} = 0,75 \cdot 0.03346875 = 0,0251$$

Determining the required  $\rho$  :

$$\begin{aligned} \rho_{\text{perlu}} &= \frac{0,85 \cdot fc}{fy} \left( 1 - \sqrt{1 - \frac{2 \cdot Mn}{0,85 \cdot fc \cdot b \cdot d^2}} \right) \\ &= \frac{0,85 \cdot 25}{400} \left( 1 - \sqrt{1 - \frac{2 \cdot 460700}{0,85 \cdot 25 \cdot 1000 \cdot 94^2}} \right) = 0.0001305 \end{aligned}$$

$$\rho_{\text{perlu}} = 0.0002 < \rho_{\min} = 0.0035, \text{ then used } \rho_{\min} = 0.0035$$

The area of reinforcement needs to be :

$$aslx = \rho_{\min} \cdot b \cdot d = 0.0035 \cdot 1000 \cdot 94 = 329 \text{ mm}^2$$

Wearable reinforcement  $\emptyset 12 \text{ mm}$

$$\text{Required reinforcement distance} = \left( \frac{\pi / 4 \cdot \phi^2 \cdot b}{Aslx} \right) = \left( \frac{\pi / 4 \cdot \phi^2 \cdot 1000}{329} \right) =$$

$$343,899 \text{ mm}$$

Then the reinforcement distance (s) = 120 mm is taken

Plate strength control:

- $s = 150 \text{ mm} < s_{maks} = 3 \cdot h = 3 \cdot 120 = 360 \text{ mm}$
- Reload area per m ( $A_x$ ) =  $329 \text{ mm}^2 > A_{smin} = 0.002 \cdot s \cdot b$   
 $= 0,002.120.1000$   
 $= 240 \text{ mm}^2$
- $a = \frac{A_s \cdot f_y}{0,85 \cdot f_c \cdot b} = \frac{329.400}{0,85.25.1000} = 6,193 \text{ mm}$
- $M_n = A_s \cdot f_y \cdot (d - a/2) = 329.400 \cdot (94 - 6,193/2) = 11436500 \text{ Nmm}$   
 $\phi M_n = 1.2 \cdot 7413875 = 11436500 \text{ Nmm} = 11.436500 \text{ kNm} > M_u = 5.529 \text{ kNm} \rightarrow \text{OK}$

## CONCLUSION

Based on the discussions that have been carried out, the conclusion of the planning of the helicopter field plate in the Nagreg area shows that the construction of a heliport at the location is very necessary to overcome the problem of congestion that often occurs on the Cileunyi-Nagreg road section, especially during the homecoming season. The calculation of the structure of the plates and beams showed that the dimensions and thickness of the plates were in accordance with applicable planning standards, and the results of the analysis showed that the heliport could be designed using the right materials to ensure robustness and reliability. With this heliport facility, it is hoped that it can improve transportation efficiency and provide long-term solutions to congestion in the area.

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