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Inspection Road Planning at Djalaluddin Gorontalo Airport

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ABSTRACT
Djalaluddin Gorontalo Airport is an airport located in Tibawa District, Gorontalo Province. This airport has a runway measuring 2,500 x 45 meters. Therefore, supporting facilities are needed in the form of inspection roads with flexible pavements in accordance with SKEP 347/XII/1999. This study uses the Road Pavement Design Manual method No.03/M/BM/2024 to determine the thickness of the pavement. As for the budget plan, this journal uses the 2024 Gorontalo Province HSPK and PM 78 of 2014. Based on the calculation results, the thickness of the flexible pavement for the inspection road at Djalaluddin Gorontalo Airport is 420 mm, consisting of a 50 mm thick AC-WC layer, 220 mm thick class A LFA, and 150 mm thick class B LFA. The total cost required for this inspection road work is Rp9,397,329,000.00.

1. INTRODUCTION

Djalaluddin Gorontalo Airport is located in Isimu District, Gorontalo Regency, Gorontalo Province. This airport has a runway measuring 2,500 m x 45 m facing 09-27 and is capable of serving Boeing 737-800 NG/900 ER aircraft. Airlines currently operating at this airport include Garuda Indonesia, Lion Air, and Batik Air. Currently, Djalaluddin Airport is not equipped with inspection road facilities. In accordance with KM 52 of 2023 concerning the master plan for Djalaluddin Airport in Gorontalo Regency, inspection roads are an important part of the plan to maintain the safety of flight operations.

This is also in line with the Regulation of the Minister of Transportation PM 33 of 2015, which states in Article 4 paragraph 1 point f that domestic airports must have inspection roads. Inspection roads are needed for routine maintenance checks, ensuring compliance with flight safety regulations, Monoarfa et al. (2024). Airport development is in line with a broader economic strategy, similar to the role of tourism in Gorontalo City, which increases local business and employment opportunities, Pala et al. (2024). Although the absence of an inspection road poses challenges, its future implementation could significantly improve operational safety and efficiency, ultimately benefiting the local economy and tourism sector.

2. LITERATURE REVIEW

2.1. Inspection Road

According to SKEP 347/XII/99, an airport inspection road is a road that surrounds the airport perimeter used for routine facility inspections. The proposed flexible pavement inspection road consists of three parts: natural ground surface pavement, embankment pavement, and excavation pavement. Natural airport surfaces require sufficient load-bearing capacity to prevent damage to aircraft and infrastructure, Wesołowski et al. (2022). The use of geogrids can significantly increase the load-bearing capacity of these surfaces, ensuring rapid recovery of operational capacity, Wesołowski et al. (2022). Excavation sites must be carefully managed to prevent instability, which can compromise safety, Gkyrtis et al. (2024). Non-destructive testing methods, such as the Falling Weight Deflectometer, can help evaluate the condition of excavated areas and ensure they meet safety standards, Gkyrtis et al. (2024).

2.2. Road Pavement Design Manual No.03/M/BM/2024

The Inspection Road applies MDPJ 2024. The selection of this method is to select the thickness and hardness of the inspection road because there are many journals that apply this method to determine the thickness and hardness of the road. It is a method created by the Ministry of Public Works so that it can be applied in Indonesia. According to Flexible Pavement Planning, the inspection road includes all hard layers of the road, from the base soil, subbase layer, upper base layer, and surface layer.

The MDPJ 2024 method combines a mechanistic-empirical approach, ensuring that the design meets the safety criteria for fatigue cracking and permanent deformation, Adiman & Pranata (2024). It covers all layers of the road structure, including the base soil, lower and upper base layers, and surface layers, providing a holistic view of the integrity of the pavement, Adiman & Pranata (2024). This method also takes into account actual traffic loads, adjusting design parameters to reduce damage due to overloading, Erzag et al. (2024). The MDPJ method has been successfully applied in various case studies, demonstrating its adaptability and reliability in real-world scenarios, Fadilla et al. (2024). Advanced technologies, such as GPR, are being integrated to improve the accuracy of layer thickness assessment, further supporting the MDPJ framework, Batrakova et al. (2024).

2.3. Design CBR

The CBR value of the soil comes from Djalaluddin Gorontalo Airport in 2023, which was carried out to obtain the CBR value of the soil in the perimeter area of Djalaluddin Gorontalo Airport. To determine the characteristic CBR using the percentile method, because 10% of the segment data is less than or according to the percentile CBR value, the CBR value used is the value of the 10th percentile. Alternatively, the CBR value at the percentile is greater than or equal to 90% of the CBR value in the uniform section. The percentile method procedure used involves Microsoft Excel software, where you use the excel formula = PERCENTILE (array, k). Here, “array” refers to the data set, and k is the percentile.

The CBR value is very important for designing flexible pavement systems, as it reflects the bearing capacity of the subsoil. Sapta et al. (2023). The CBR value can be affected by soil properties such as plasticity index and water content, which are important for accurate assessment. Sapta et al. (2023), Farias et al. (2024). While the percentile method provides a structured approach to determining CBR values, it is important to consider that variations in soil composition and external factors, such as seismic activity, can significantly affect the results and their application in real-world scenarios. Çetin et al. (2024)

2.4. Cumulative Standard Axle Load

The cumulative standard axle load, often referred to as Cumulative Equivalent Single Axle Load (CESAL), is the total axle load accumulated from design traffic on a lane during the design period and is determined as follows:

$$ESATH - 1 = (\sum LHRJK \times VDFJK) \times 365 \times DD \times DL... [1]$$

Description :
ESATH-1: Cumulative Equivalent Standard Axle Track Value for the First Year.
LHRJK: Average Track Value for each type of commercial vehicle (in vehicles per day).
VDFJK: Vehicle Damage Factor for each type of vehicle.
DD: Directional Distribution Factor.
DL: Lane Distribution Factor.
CESAL : Total equivalent standard axle load during the design period
R: Cumulative Traffic Growth Multiplication Factor.

3. METHODOLOGY

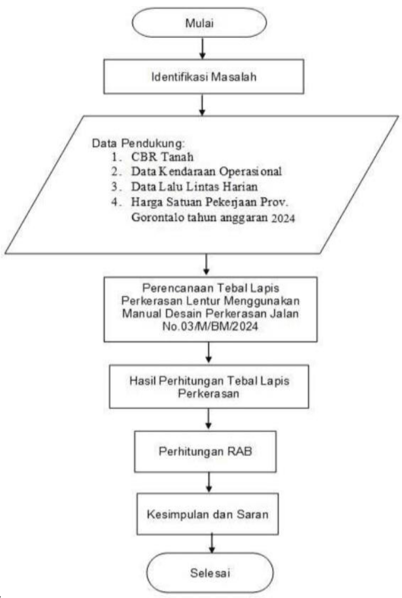

Figure 1. Research Design

4. RESEARCH RESULTS

4.1. General Planning Overview

Currently, Djalaluddin Airport does not have an inspection road as a security facility in flight operations. Inspection activities themselves temporarily use an inspection road in the form of a landfill around the fence of the access road from apron A to apron B, so it does not cover all parts of Djalaluddin Airport. The survey results show that the inspection road is still inadequate and difficult to pass during the rain, so the author plans to make a flexible pavement plan for the inspection road at Djalaluddin Airport, Gorontalo.

4.2. Data Collection

In the planning of flexible road construction at Djalaluddin Airport, there is supporting data obtained from related sources; secondary data obtained by the author are:

1. Soil CBR data
   The CBR data for soil at Djalaluddin Airport, Gorontalo, was obtained by the author from the airport when conducting on-the-job training.
2. Operational Vehicle Data
   Operational vehicle data is taken from the Aerodrome Manual of Djalaluddin Airport, Gorontalo.
3. Daily Traffic Data
   DLH was obtained from direct observation in the field and observing the dominant vehicles passing through the temporary inspection road at Djalaluddin Gorontalo Airport.
4. Unit Price
   The unit price of wages and materials uses the standard cost of Gorontalo Province for the 2024 budget year.

5. DISCUSSION

5.1. Traffic data

The inspection road DLH at Djalaluddin Airport, Gorontalo, can be seen in the following table 1:

Table 1. Inspection Road Traffic Data at Djalaluddin Airport

Vehicle Type	VLHR
2 ton light vehicle	38
Large vehicles	19
Total	57

(Source: Inspection Road Traffic Survey Results, 2024)

For the Djalaluddin Airport Inspection Road, the type of village road is used because of the low daily traffic and also the traffic growth in accordance with the 2024 MDPJ. The following planning related to inspection road traffic at Djalaluddin Airport, Gorontalo, can be seen in the following table 2:

Table 2. Inspection Road Traffic Planning Data

Data	Description
Road type	Village
Planned Age (UR)	20 Years
Traffic Growth (i)	1%
Vehicle Distribution	one lane two way

(Source: Ministry of PUPR; Bina Marga, 2024)

5.2. Determining the VDF Value

Each vehicle on the Djalaluddin Airport inspection road is classified as follows:

a) Light heavy vehicles 2 tons are classified as classes 2, 3, and 4.
b) Large buses are classified as 5B

After classifying vehicles on the Djalaluddin Airport inspection road, the VDF value for each commercial vehicle is determined based on the following table:

Table 3. VDF Value of Each Type of Vehicle at Djalaluddin Airport

Kondisi	Kelas Kendaraan	Gol 5B	Gol 6A	Gol 6B	Gol 7A1	Gol 7A2	Gol 7A3	Gol 7B1	Gol 7B2	Gol 7B3	Gol 7C1	Gol 7C2A	Gol 7C2B	Gol 7C3	Gol 7C4
VDF4	Faktual	1,2	0,5	0,9	-	16,9	-	-	-	-	10,5	10,7	-	24,8	-
	Normal	1,2	0,5	0,4	-	4,9	-	-	-	-	6,8	4,1	-	9,7	-
VDF5	Faktual	1,3	0,4	0,9	-	34,0	-	-	-	-	15,2	19,7	-	48,9	-
	Normal	1,3	0,4	0,3	-	6,6	-	-	-	-	8,9	5,5	-	14,6	-

(Source: Ministry of PUPR; Bina Marga, 2024)

Based on the VDF table above, the calculation results are:

a. 2-ton light vehicles are classified as 2, 3, 4 with a VDF value of 5 (normal).
b. Large buses are classified as 5B with a VDF value of 4 (normal) 1.2 and VDF 5 (normal) 1.3.

5.3. Determining Traffic Growth Factor

To determine the traffic growth factor during the normal load period during the design life (20 years), based on the following formula:

$$R=\frac{(1+i)^{UR}-1}{i}$$

$$R=\frac{(1+0{,}01)^{20}-1}{0{,}01}$$

$$R=22$$

5.4. Determining the Lane Factor Distribution (DL)

The lane distribution factor can be determined based on table 4 as follows:

Table 4. Lane Distribution Factor of Djalaluddin Airport Inspection Road

number of lanes in each direction	Commercial vehicles on **design lanes** (% of commercial vehicle population)
1	100
2	80
3	60
4	50

(Source: Ministry of PUPR; Bina Marga, 2024)

From the table above, the value of the distribution factor for a 1-lane, 2-way road can be determined to be = 100% or DL = 1.

5.5. Determining the Direction Factor Distribution (DD)

According to the 2024 Bina Marga Design Manual, for two-way roads, the distribution factor is 0.5.

5.6. Cumulative Standard Axle Load (CESAL)

Determination of the equivalent standard axle load (ESA) uses formula 1, which is listed above. From the calculation results above, the cumulative value of the single axle load equivalent (CESAL) during the design life (20 years) is obtained in table 5.

Table 5. Accumulated value of axle load during the standard equivalent design life

Type Vehicle	LHR 2024	LHR 2044	VDF 4	VDF5	ESA 4	ESA 5
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Light vehicles 2 tons	38	46,4	0	0	0	0
Large Bus	19	23,2	1,2	1,3	111.699	121.007
Total CESAL					111.699	121.007

(Source: CESAL Calculation Results using Excel)

(3) = (2) x (1+0.01)^20
(4) and (5) from table 3
(6) = (3) x (4) x 365 x 0.50 x 1 x R(2024-2044)*
(7) = (3) x (5) x 365 x 0.50 x 1 x R(2024-2044)*

5.7. Pavement Type Determination

The number of vehicles, anticipated service life, and road foundation conditions all play a role in selecting a pavement. Table 6 can be used to select a CESAL5 pavement type. For a 20-year plan, the total CESAL4 value is 121,007, as calculated in table 5

Table 6. Selection of Pavement Type

Struktur Perkerasan	Bagan Desain	ESA5 (juta) dalam 20 tahun				
		0 - 1	1 - 4	4 - 10	>10 – 30	>30
AC modifikasi	3, 3A, 3B	-	-	-	-	2
AC dengan CTB					2	-
AC Modifikasi dengan CTB					-	2
AC dengan lapis fondasi agregat	3, 3A, 3B	-	1, 2	1, 2	2	-
HRS tipis di atas lapis fondasi agregat	4	2	2	-	-	-
Burda atau Burtu dengan lapis fondasi agregat	5	3	3	-	-	-
AC/HRS dengan lapis fondasi *Soil Cement*	6	2	2	-	-	-
AC/HRS dengan lapis fondasi agregat dan perbaikan tanah dasar (dengan stabilisasi semen)	7	2	2			
Perkerasan kaku dengan lalu lintas berat	8	-	-	-	2	2
Perkerasan kaku dengan lalu lintas rendah	8A	-	-	1, 2	-	-
Perkerasan tanpa penutup (Japat dan jalan kerikil)	9	1	-	-	-	-

(Source: Ministry of PUPR; Bina Marga, 2024)

Based on table 6, the type of pavement for the CESAL5 value of the Djalaluddin Airport inspection road is in the range of 01-0.5 million ESA5, so the AC WC (asphalt concrete) pavement structure is selected in design chart 7 (ESA 4).

5.8. Planned Foundation Design

To determine the foundation design of the Djalaluddin Gorontalo Airport inspection road plan, CBR data that has been tested using the tool is required, and the data will determine the characteristic CBR value to be adjusted to the minimum foundation design. The following is the characteristic CBR from the Djalaluddin Airport inspection road location:

Table 7. CBR characteristics of the Djalaluddin Airport planned inspection road

No.	STA	CBR Rata-Rata
1.	0+100	8,32%
2.	0+200	7,80%
3.	0+300	6,74%
4.	0+400	7,65%
PERCENTILE		7,01%

(Source: Results of CBR characteristic calculations using Excel)

Determination of the foundation using the 2024 highway design method is emphasized on the existing subgrade conditions and the CESAL5 value. Next, after the CESAL5 value and the CBR value of the basic soil characteristics are known to be 7.01%, the determination of the foundation is based on table 8:

Table 8. Minimum Road Foundation Design on Inspection Roads

CBR Tanah dasar (%)	Kelas Kekuatan Tanah Dasar	Uraian Struktur Fondasi	Perkerasan Lentur Beban lalu lintas pada lajur rencana dengan umur rencana 40 tahun (juta ESA5)		
			< 2	2 - 4	> 4
			Tebal minimum perbaikan tanah dasar		
≥ 6	SG6	Perbaikan tanah dasar dapat berupa stabilassi semen atau material timbunan pilihan (sesuai persyaratan Spesifikasi Umum, Devisi 3 – Pekerjaan Tanah) (pemadatan lapisan ≤ 200 mm tebal gembur)	Tidak diperlukan perbaikan		
5	SG5		-	-	100
4	SG4		100	150	200
3	SG3		150	200	300
2,5	SG2.5		175	250	350
Tanah ekspansif (potensi pemuaian > 5%)			400	500	600
Perkerasan di atas tanah lunak[2]	SG1 (3)	Lapis penopang[4][5]	1000	1100	1200
		-atau- lapis penopang dan geogrid (4) (5)	650	750	850
Tanah gambut dengan HRS atau DBST untuk perkerasan untuk jalan raya minor (nilai minimum – ketentuan lain berlaku)		Lapis penopang berbutir[4][5]	1000	1250	1500

(Source: Ministry of PUPR; Bina Marga, 2024)

It can be seen from table 8 that if the CBR value of the basic soil reaches 6% or more, no soil improvement is required before carrying out paving work.

5.9. Pavement Thickness Design

Referring to the results of the CESAL4 calculation, the selection of the type of pavement used, namely design chart 7, is found in Bina Marga 2024, which is shown in table 9.

Table 9. Flexible Pavement Design on the Djalalauddin Airport Inspection Road

	STRUKTUR PERKERASAN[1]		
	SC1	SC2	SC3
	Beban Sumbu 20 tahun pada lajur desain ($ESA4 \times 10^6$)		
	< 0,1	0,1- 0,5	> 0,5 – 4
	Ketebalan lapis perkerasan (mm)		
HRS WC, AC WC		50*	
Lapis Fondasi Agregat Kelas A	160	220	300
Lapis Fondasi Agregat Kelas B	110	150	200
Stabilisasi tanah asli hingga mencapai CBR ekuivalen 6%	160	200	260

(Source: Ministry of PUPR; Bina Marga, 2024)

Based on table 4, original soil stabilization is not required because the CBR value at the Djalaluddin Airport inspection road location is > 6%, so the following results are obtained:
1) AC WC: 50 mm
2) LFA Class A: 220 mm
3) LFA Class B: 150 mm

5.10. Pavement Thickness Design

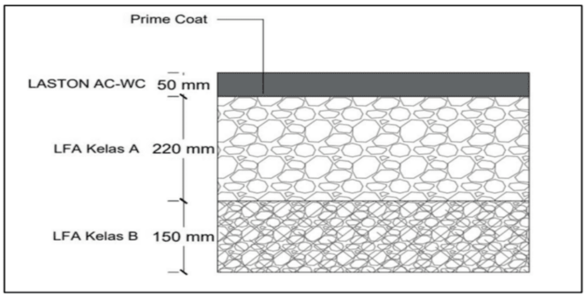

Figure 2. Flexible Pavement Design for the Djalalauddin Airport Inspection Road
(Source: Author's Processed Results, 2024)

5.11. Budget Plan

The thickness of the road pavement layer is then calculated using the HSPK of Gorontalo Province in 2024 and PM 78 of 2014. The results of the calculation of the Djalaluddin Gorontalo Airport Budget Plan for Road Inspection Planning are as follows:

Table 10. Budget Plan (RAB) for Djalaluddin Airport Inspection Road

NO	URAIAN JENIS PEKERJAAN	SATUAN	Volume	Harga Satuan (Rp)	Jumlah Harga (Rp)
1	2	4	5	8	9
I	**PEKERJAAN PERSIAPAN**				
1	Pengukuran	m2	31000	Rp 5.069,20	Rp 157.145.200,00
2	Direksi keet	m2	36	Rp 453.695,51	Rp 16.333.038,36
3	Papan Nama Proyek	unit	1	Rp 953.397,75	Rp 953.397,75
4	Mobilisasi dan demobilisasi	Ls	1	Rp 29.541.000,00	Rp 29.541.000,00
II	**PEKERJAAN LAPISAN PERKERASAN**				
1	Pekerjaan urugan dan pemadatan tanah tebal 20 cm	m3	6200	Rp 283.315,20	Rp 1.756.554.240,00
2	Pekerjaan lapisan agregat base kelas B tebal 15 cm	m3	4650	Rp 178.318,10	Rp 829.179.165,00
3	Pekerjaan lapisan agregat base kelas A tebal 22 cm	m3	6820	Rp 182.518,10	Rp 1.244.773.442,00
4	Pekerjaan lapisan perekat prime coat	m2	31000	Rp 64.023,18	Rp 1.984.718.580,00
5	Pekerjaan lapisan perekat tack coat	m2	31000	Rp 35.108,18	Rp 1.088.353.580,00
6	Pekerjaan lapisan AC-WC tebal 5 cm	m3	1550	Rp 876.458,21	Rp 1.358.510.225,50
				JUMLAH	**Rp 8.466.061.868,61**
				PPN 11%	**Rp 931.266.805,55**
				TOTAL JUMLAH	**Rp 9.397.328.674,16**
				DIBULATKAN	**Rp 9.397.329.000,00**
terbilang sembilan miliar tiga ratus sembilan puluh tujuh juta tiga ratus dua puluh sembilan ribu rupiah					

(Source: Author's Processed Results, 2024)

The Djalaluddin Gorontalo Airport Inspection Road Work has a dimension of 5 meters wide and 6,200 meters long inspection road work. The final results of the calculation of the Budget Plan (RAB) that have been carried out resulted in a total cost of Rp9,397,329,000.00.

6. CONCLUSION AND RECOMMENDATION

In accordance with the results of the calculations and analyses that have been carried out previously, the following conclusions can be drawn:

1. The results of the inspection road pavement structure planning using flexible pavement types using the MDPJ 2024 method are as follows: Surface course: LASTON AC-WC, Base course: LFA class A; subbase course: LFA class B.
2. The results of the inspection road pavement thickness calculation obtained using the MDPJ 2024 method are: surface course: 50 mm, base course: 220 mm, subbase course: 150 mm.
3. The flexible pavement thickness design used for the inspection road at Djalaluddin Gorontalo Airport is LASTON AC-WC with a thickness of 50 mm, LFA class A with a thickness of 220 mm, and LFA class B with a thickness of 150 mm.
4. The budget plan for the construction of the inspection road at Djalaluddin Gorontalo Airport is IDR 9,397,329,000.00.

In the implementation of realizing flexible pavement of inspection road to maximize our plan, we suggest that if the inspection road planning is carried out in a different year from the initial plan, the manager should conduct a review of the basic unit price in the related area. This is to ensure that the manager obtains the latest basic unit price in accordance with the plan that has been analyzed.

FURTHER RESEARCH

Further research can take into account the geometric factors on the inspection road in order to adjust the land contour at the inspection road construction location.
This research uses a research and development approach to develop new tools through a design, manufacturing, and testing process.

REFERENCES

[1] Adiman, E. Y., & Pranata, A. Y. (2024). Analisis desain perkerasan lentur berdasarkan mdpj 2017 menggunakan metode mekanistik empiris pada program kenpave. Jurnal Mitra Teknik Sipil, 651–662. https://doi.org/10.24912/jmts.v7i2.26800

[2] Batrakova, A. G., Dorozhko, Y., Urdzik, S., & Shelkova, I. G. (2024). Development of the algorithm for determining the thickness of the structural layers of the non-rigid pavement and searching for local inclusions using sub-surface georadiolocation methods. Vestnik Har′kovskogo Nacional′nogo Avtomobil′no-Dorožnogo Universiteta, 106, 125. https://doi.org/10.30977/bul.2219-5548.2024.106.0.125

[3] Çetin, K. Ö., Çakır, E., EYİGÜN, Y., & Gökçeoğlu, C. (2024). Soil liquefaction manifestations at Hatay Airport after the February 2023 Türkiye earthquake sequence. Earthquake Spectra. https://doi.org/10.1177/87552930241285024

[4] Direktorat Keselamatan Penerbangan. (1999). SKEP 347-XII-1999 Tentang Standar Rancang Bangun dan Rekayasa Fasilitas dan Peralatan Bandar Udara.

[5] Erzag, A. N., Sentosa, L., & Putra, B. H. R. (2024). Perbandingan VDF Jembatan Timbang Tanjung Balik Terhadap VDF MDPJ 2017 Berdasarkan Beban Aktual. Cantilever: Jurnal Penelitian Dan Kajian Teknik Sipil. https://doi.org/10.35139/cantilever.v12i2.191

[6] Fadilla, N. N., Widiastuti, M., & Gultom, T. H. M. (2024). EVALUASI KONDISI PERKERASAN JALAN MENGGUNAKAN METODE PAVEMENT CONDITION INDEX (PCI) PADA PERKERASAN KAKU (Studi Kasus : Jalan Modern Poros SP 1 – Sebulu). Teknologi Sipil/Jurnal Teknologi Sipil, 8(1), 57. https://doi.org/10.30872/ts.v8i1.16029

[7] Farias, R., Paranhos, H., & Costa, D. (2024). Caracterização, compactação e CBR (ISC), pelo Método DIRENG-ME-01/87, realizado em Latossolo típico do Centro-Oeste Brasileiro para uma área no Aeroporto Internacional Presidente Juscelino Kubitschek, Brasília / Distrito Federal. International Seven Multidisciplinary Journal, 3(2), 637–647. https://doi.org/10.56238/isevmjv3n2-020

[8] Gkyrtis, K., Armeni, A., Plati, C., & Loizos, A. (2024). An efficient approach for NDT diagnosis of defect causes in airfield concrete pavements. https://doi.org/10.5194/egusphere-egu24-8322

[9] Menteri Perhubungan Republik Indonesia (2023). KM 52 Tahun 2023 Tentang Rencana Induk Bandar Udara Djalaluddin di Kabupaten Gorontalo Provinsi Gorontalo.

[10] Menteri Perhubungan Republik Indonesia. (2015). PM 33 Tahun 2015 Tentang Pengendalian Jalan Masuk (ACCESS CONTROL) ke Daerah Keamanan Terbatas di Bandar Udara.

[11] Monoarfa, V., Isima, A., & Genda, A. P. (2024). Analisis Biaya Lingkungan pada Rumah Sakit Islam Gorontalo. Journal of Management and Business, 3(2). https://doi.org/10.47467/manbiz.v3i2.5561

[12] Pala, R., Popoi, I., Mahmud, M., Panigoro, M., & Sudirman, S. (2024). Peran Dinas Pariwisata Dalam Meningkatkan Perekonomian di Kota Gorontalo. https://doi.org/10.37479/jebe.v2i3.27136

[13] Pergub No.19 th 2023, Standar harga Satuan Regional Provinsi Gorontalo Tagun Anggaran 2024.

[14] Prime, M. B. (2024). Comparison Calculation Thick Pavement Rigid (Rigid Pavement) Between Method Manual Design Pavement Road (Revision 2017) With Method Build Clan Pd-T-14-2003, on Ruas Road Shell Until Limit City Land Grogot East Kalimantan. 1(3), 123–137. https://doi.org/10.61132/ijmecie.v1i3.32

[15] Sapta, W., Harianto, Y., & Gofar, N. (2023). CBR Correlation with Index and Compaction Properties of Soil. Indonesian Geotechnical Journal. https://doi.org/10.56144/igj.v2i3.72

[16] Wesołowski, M., Blacha, K., & Kowalewska, A. (2022). A quick method of improving the load-bearing capacity of natural airport pavements. Przegląd Komunikacyjny, 18–27. https://doi.org/10.35117/a_eng_22_10_03