PLANNING OF RUNWAY END SAFETY AREA AT THRESHOLD 12 OF DEPATI PARBO KERINCI AIRPORT

Ayu Khadijah Purwiyadi[1*], Fahrur Rozi[2], Siti Fatimah[3]

[1,2,3)] Politeknik Penerbangan Surabaya , Jl. Jemur Andayani I No 73 Surabaya 60236
**Corresponding Author Email: ayukhadijahp@poltekbangsby.ac.id*

ABSTRACT

Depati Parbo Kerinci Airport is a Class III Airport managed by the Directorate General of Civil Aviation which has a runway with dimensions of 1800 x 30 meters. Since its inception, Depati Parbo Kerinci Airport still does not have a Runway End Safety Area (RESA) facility at the end of threshold 12. In order to reduce the impact of the risk of damage to aircraft that experience undershooting or overrunning at the time of landing or takeoff, as well as to meet the needs of operational feasibility standards, one of the things that needs to be done is to provide Runway End Safety Area (RESA) facilities which are planned in advance.

Runway End Safety Area (RESA) planning uses spot data on the situation of the airport area which is then processed into ground contour and elevation data. This planning takes into account the original ground surface condition, dimensions, and slope of the Runway End Safety Area (RESA) to complete the data in the calculation of excavations and landfills using Autodesk Civil 3D software.

The Runway End Safety Area (RESA) planning at threshold 12 of Depati Parbo Kerinci Airport is planned to have dimensions of 90 x 60 m with a percentage of longitudinal slope of 1% and a transverse slope of 2%. In the excavation and stockpile work, a total excavation volume of 3156.48 m3 and a stockpile volume of 2.08 m3 were obtained with a planned cost budget of Rp668,100,000.00.

Keywords: Airport, Runway End Safety Area, RESA, Civil 3D, excavation, landfill.

1. INTRODUCTION

Depati Parbo Kerinci Airport (IATA Code: KRC; ICAO Code: WIJI) is located at coordinates 02° 05' 27.5" S and 101° 27' 47.0" E on Jalan Angkasa Pura, Angkasa Pura Hiang Village, Sitinjau Laut District, Kerinci Regency, Jambi Province. It is located at an altitude of 2607 ft above sea level. Depati Parbo Kerinci Airport is one of the Class III Airport Operating Units managed by the Directorate General of Civil Aviation (Depati Parbo Kerinci Airport Operating Unit, 2022).

Kerinci Regency is an area prone to natural disasters because of its geographical location at the foot of Mount Kerinci and close to the Sumatra Large Fault Zone or Semangko Fault. The Semangko Fault is a fault that divides the island of Sumatra from Aceh to Lampung and stretches along the west side of the island of Sumatra. The initial purpose of the establishment of Depati Parbo Kerinci Airport was as a disaster evacuation route and a place for distributing relief goods. Depati Parbo Kerinci Airport serves domestic flights with Kerinci (KRC) Jambi (DJB) flight routes back out.

Initially, Depati Parbo Kerinci Airport was built on a highway which was then converted into a runway area with dimensions of 1800 meters long and 30 meters wide. Other airside facilities at this airport are connecting runways (taxiway), parking runway (apron), stopway, runway strip, and RESA at threshold 30 (Depati Parbo Kerinci Airport Operating Unit, 2022). Until now, the largest aircraft that can be served by Depati Parbo Kerinci Airport is the ATR 72-600.

Depati Parbo Kerinci Airport will continue to be developed in accordance with the Master Plan of Depati Parbo Kerinci Airport in 2008. Currently, Depati Parbo Kerinci Airport is in the construction stage of a new facility, where land-side facilities will be moved from the old location to the new location. The development of this new facility is expected to be able to increase flight traffic and the number of annual passengers at Depati Parbo Kerinci Airport.

All facilities in the airport area have strict regulations that must be met in order to realize aviation security and safety. One of the important facilities at the airport that must be available in accordance with regulations is the Runway End Safety Area (RESA). Runway End Safety Area (RESA) is a runway extension area that aims to reduce the risk of aircraft damage in the event of an incident such as a runway excursion. The aircraft can be said to have experienced a runway excursion (slipping) if there is an incident where the aircraft goes off the runway either at the end of the runway (over run) or on the right or left side of the runway (veer off), which is caused by pilot error, bad weather, or damage to the aircraft.

The National Transportation Safety Committee (KNKT) has carried out an investigation into aircraft accidents with a total of 280 accidents that occurred in Indonesia, of which 105 were runway excursion incidents or 37.5% of the total incidents (Saputra, 2017). As an effort to prevent unexpected incidents, it is necessary to fulfill facilities in the form of Runway End Safety Areas (RESA).

According to a letter issued by the Head of the Padang Region VI Airport Authority Office Number: AU.107/22/25/OBU. VI-2023 dated September 13, 2023, it was stated that there was no Runway End Safety Area (RESA) threshold 12 at Depati Parbo Kerinci Airport. In accordance with the Regulation of the Director General of Civil Aviation Number PR 21 of 2023 concerning Technical and Operational Standards of Civil Aviation Safety Regulations, that a Runway End Safety Area (RESA) must be available at each end of the runway strip. The existing condition of the Runway End Safety Area (RESA) plan location at threshold 12 of Depati Parbo Kerinci Airport is in the form of a large area overgrown with shrubs and weeds and has not been released.

The existing condition of threshold 12 is very close to the parimeter fence, which is dangerous and certainly not in accordance with applicable regulations. Important things that must be considered in planning a Runway End Safety Area (RESA) are length and width, slope, strength, and surface.

Based on the background that has been described earlier, several problems can be formulated, namely as follows.

1. How is the mapping of the soil contour situation of the Runway End Safety Area (RESA) planning land at threshold 12 of Depati Parbo Kerinci Airport using the Autodesk Civil 3D program?
2. What is the volume of excavation and stockpile needed in the plan to make a Runway End Safety Area (RESA) at threshold 12 of Depati Parbo Kerinci Airport?
3. What is the Cost Budget Plan in planning the Runway End Safety Area (RESA) at Depati Parbo Kerinci Airport?

The purpose of this research can be described as follows.

1. Creating a mapping image of the land contour situation in the Runway End Safety Area (RESA) planning land area at threshold 12 Depati Parbo Kerinci Airport with the Autodesk Civil 3D program.
2. Determine the volume of excavation and backfill required to achieve the desired soil elevation level in accordance with applicable regulations.
3. Planning the cost budget needed in the work of making the Runway End Safety Area (RESA) at Depati Parbo Kerinci Airport.

2. THEORETICAL FOUNDATIONS

According to ICAO written in Annex 14, it is stated that the definition of Aerodrome is an area that has been determined, both on land and water, including all installations in it that are specifically intended as places of arrival, departure, and movement of aircraft (International Civil Aviation Organization, 2004).

Runway End Safety Area (RESA) is a symmetrical area along the runway axis that connects to the end of the runway and is designed to reduce the risk of damage to aircraft that land or take off too early (International Civil Aviation Organization, 2004).

Topography is the study of the shape of the earth's surface and other objects, including planets, natural satellites, and asteroids (Basuki, 2011). Topography comes from the word topos which means 'details of a place' and graphia which means 'writing'. In general, topography studies surface relief, 3-dimensional models, and identification of land types. To make a topographic map, it can be done by means of direct surveys and remote sensing.

Topographic conditions are conditions that describe the slope of the land or the contour of the land, the larger the contour of the land means that the land has a greater slope. Topographic measurements need to be carried out in excavation and soil heap work which is closely related to the calculation of soil volume (Syaripudin, 2019b). Topographic measurements can be done using waterpass measuring tools, theodolite, total stations, and others.

Excavation and fill (cut and fill) is the process of moving a certain volume of soil due to differences in height or uneven ground surface. The purpose of the cut and fill work is to level and prevent soil subsidence. In carrying out cut and fill work, measurements and calculations are needed to find out the volume of soil to be excavated and filled. Calculating the volume of excavations and piles can be done manually or using Microsoft Excel and Autocad or Civil 3D programs.

Autodesk Civil 3D is designed specifically for civil engineering and surveying work. The program can be used in various projects such as roads, land, drainage and sewerage systems, airports, land development, and railways. For land design, Autodesk Civil 3D can be used in designing building area layouts, modeling topography such as ground level, estimating soil volume, performing geotechnical analysis, and so on.

3. METHOD

This research was carried out in several stages which are depicted in the following research flow chart.

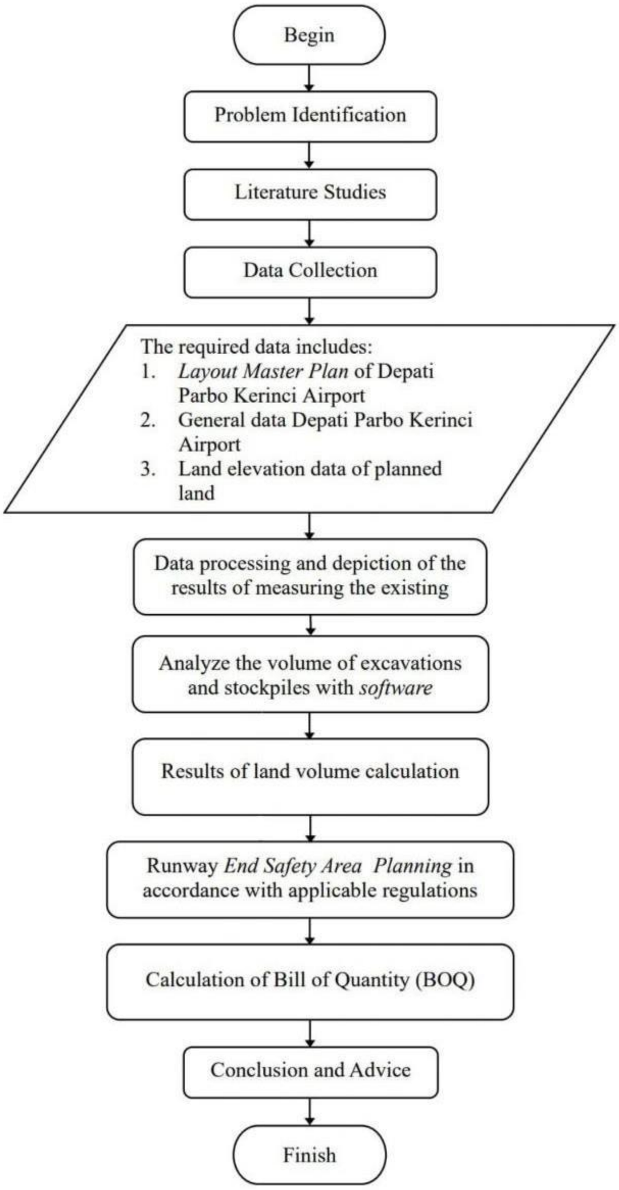

Figure 1 Planning Flow Chart

3.1. Problem Identification

Problem identification is the initial stage to find out the existing problems and is considered to be solved quickly and appropriately. Depati Parbo Kerinci Airport still does not have RESA facilities at threshold 12.

3.2. Literaure Studies

Literature study is an activity to collect data by taking notes, reviewing literature, and reading from various sources of information, which is then processed to be used as a reference in research. The sources of information used can be in the form of print media and electronic media, which are still related to the planning of the development of the Runway End Safety Area (RESA). The literature study was carried out to obtain information related to the problems taken and used as a reference in planning the construction of Runway End Safety Area (RESA) facilities.

3.3. Data Collection

Data collection was carried out during the implementation of the On the Job Training practice at Depati Parbo Kerinci Airport. The data collected is in the form of primary data and secondary data. The primary data taken is the data from the detailed measurement of the existing situation of the airport using the Total Station measuring tool. This data will be processed and produce data on the existing land elevation of the airport. The secondary data collected is general airport data, existing airport layout data, and airport Master Plan layout data.

3.4. Data Processing and Calculation

The primary data that has been taken will be further processed and analyzed to obtain contour drawings and soil elevation details in the RESA planning land area with the help of the Autodesk Civil 3D program.

3.5. RESA Planning

RESA planning begins by analyzing the needs of airport facilities in the form of dimensions and slopes that have been adjusted to applicable regulations. Then the volume of excavation and stockpile required can be calculated in determining the required Cost Budget Plan.

4. RESULTS AND DISCUSSION

4.1. Needs Analysis

1. Airport reference code analysis

   Airport reference codes are used to connect various specifications in determining the facilities needed by an airport in accordance with the aircraft operating at the airport.

   Depati Parbo Kerinci Airport has a runway facility with dimensions of 1800 x 30 meters with the most critical aircraft, namely ATR 72-600, which means it has an Aeroplane Reference Field Length value of 1290 m.

Table 1. Aircraft Characteristic Data

JENIS PESAWAT	REF CODE	KARAKTERISTIK PESAWAT UDARA					
		ARFL (m)	Lebar sayap (m)	OMGWS (m)	Panjang (m)	MTOW (kg)	TP (Kpa)
Airbus A320	3C	2090	34.1		37.6	73500	1140
Airbus A319	3C	1520	34.1		33.8	64000	1070
CESSNA CAR-206	1A	274	10.9	2.6	8.6	1639	
DASH 6	1B	695	19.8	4.1	15.8	5670	220
CN-235-300	1C	1200	25.81	7	21.4	16500	626
DASH 7	1C	910	28.3	7.8	24.6	19505	
C 208	1A	274	10.9	2.6	8.6	1639	
CASSA 212-300	2B	866	20.3	3.6	16.1	8100	
Dornier 328-100	2B	1090	20.1		21.3	13.988	
Dornier 328-300	2B	1088	21		21.3	13.988	
ATR 42-500	2C	1160	24.6	4.1	22.7	18600	790
DASH 8 (300)	2C	1100	27.4	8.5	25.7	18642	805
MA 60	2C	1100	29.2		24.71	21800	
Challenger 605	3B	1780	19.61		20.85	21900	
Snort 330-200	3B	1310	22.76		17.69	10387	
ATR 72-500	3C	1220	27	4.1	27.2	22500	
ATR 72-600	3C	1290	27.05	4.1	27.16	22800	

Element 1 code is based on the length of the runway for the aircraft to use. Based on the data in Figure 4.1, it is known that the ARFL value of the most critical aircraft at Depati Parbo Kerinci Airport is 1290 m, which according to Table 4.7 means that the value is classified into a number code of 3.

Table 2. Aerodrome Reference Code (Code Element 1)

Code Number	*Code Element 1 Aeroplane Reference Field Length*
1	Kurang dari 800 m
2	800 m dan lebih tapi tidak sampai 1.200 m
3	1.200 m dan lebih tapi tidak sampai 1.800
4	1.800 m dan lebih

Element code 2 based on the aircraft's wingspan. According to the data in Figure 4.1, it can be known that the wingspan length of the ATR 72-600 aircraft is 27.05 m, according to Table 4.8 below the size includes the letter C code group.

Table 3. Aerodrome Reference Code (Code Element 2)

Code Letter	*Code Element 2 Wingspan*
A	Hingga tapi tidak sampai 15 m
B	15 m dan lebih tapi tidak sampai 24 m
C	24 m dan lebih tapi tidak sampai 36 m
D	36 m dan lebih tapi tidak sampai 52 m
E	52 m dan lebih tapi tidak sampai 65 m
F	65 m dan lebih tapi tidak sampai 80 m

Based on the above analysis, it can be concluded that the reference code of Depati Parbo Kerinci Airport according to the most critical aircraft ATR 72-600, namely 3C.

2. RESA dimensional analysis

Depati Parbo Kerinci Airport has runway dimensions of 1800 x 30 m. This airport has the most critical aircraft ATR 72-600 with the airport reference code 3C. Based on PR 21 of 2023, the dimensions and location of the Runway End Safety Area (RESA) for Depati Parbo Kerinci Airport can be known as follows:

a. For airports with code number 3, the Runway End Safety Area (RESA) must extend to a distance of at least 90 m calculated from the end of the runway strip.

b. The Runway End Safety Area (RESA) width must be at least twice the width of the runway. The width of the runway at Depati Parbo Kerinci Airport is 30 m, so the recommended RESA width based on regulations is 60 m.

c. The location of the Runway End Safety Area (RESA) is at the end of the runway strip. The distance of the runway strip from the end of the runway end is 60 m for code number 3.

Based on the adjustment with PR 21 of 2023 regulations above, conclusions can be drawn regarding the dimensions of RESA that are in accordance with Depati Parbo Kerinci Airport, which is 90 x 60 meters and is located at 60 meters from the end of the runway end.

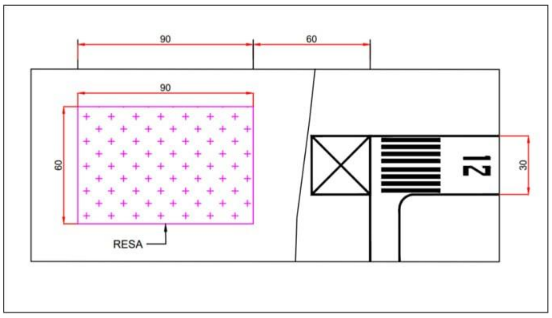

Figure 2 RESA Plan Dimensions

3. RESA slope analysis

a. Longitudinal slope

The Runway End Safety Area (RESA) of Depati Parbo Kerinci Airport is planned by determining an elongated slope of 1%. Based on the determined slope percentage, the difference in soil elevation can be calculated as follows.

Difference in elevation (m) = Percentage of slope (%) x Area (m) .... (1)

= 1% x 90 m (RESA Length)

= 0.90 meters

b. Transverse slope

The plan for the transverse slope of the Runway End Safety Area (RESA) of Depati Parbo Kerinci Airport is determined at 2%. The planned transverse slope will be calculated from the middle of the plan

RESA or half the width of the plan. Based on the percentage of slope that has been determined, the difference in soil elevation can be calculated as follows.

Difference in elevation (m) = Percentage of slope (%) x Area (m)..(2)

= 2% x 30 m

= 0.60 meters

4.2. *Contour Plan Depiction*

The creation of contour plans requires topographic data of the soil that contains coordinate and elevation information. Here are the steps to create a contour plan drawing using Autodesk Civil 3D software.

1. In the soil topographic measurement data in Microsoft Excel, copy the S, T, and U columns containing the X, Y, and Z elevation coordinates into a new excel sheet. Then save it as a .txt file. This .txt file will later be exported to the Civil 3D software.
2. Open the Autodesk Civil 3D metric software. In the start window, click new so that a new tab appears. On the toolspace tab, right-click on points, click create. A window will appear to create points. Select import points.

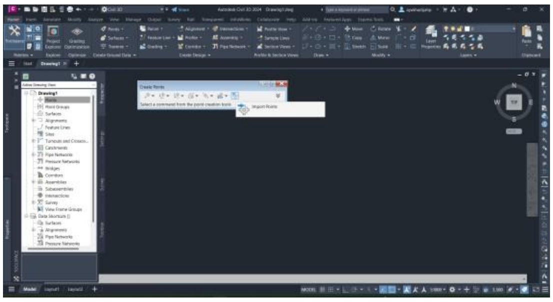

Figure 3 Import points menu

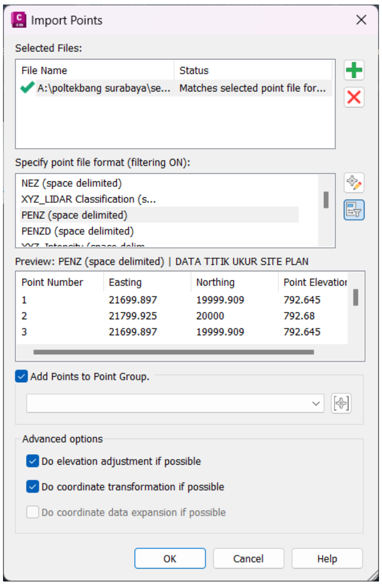

Figure 4 Import points window

In the import points window, click the green plus sign in the top right. Select the .txt file that was previously created. Adjust the point format to the format in the selected file. Click OK. Wait for the program to finish processing and displaying topographic points.

3. On the toolspace tab in the point groups set, right-click surfaces. Select create surface to create a contour image. Set the surface name and other settings, and then click OK.

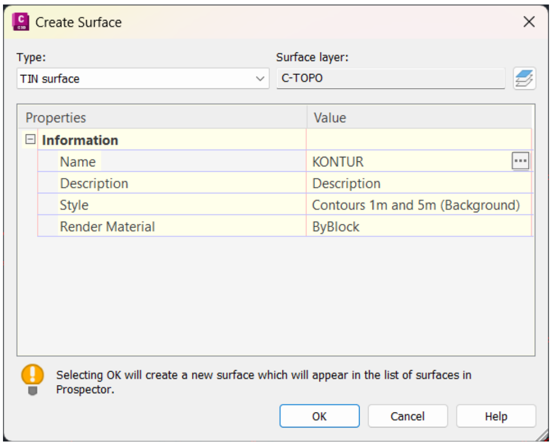

Figure 5 Create surface window

On the toolspace tab, click extend surfaces, extend 'CONTOUR', extend definition, then on the point groups right-click, select add. In the point groups window, click 'All Points' then apply and OK. Wait for the program to finish processing the contour image.

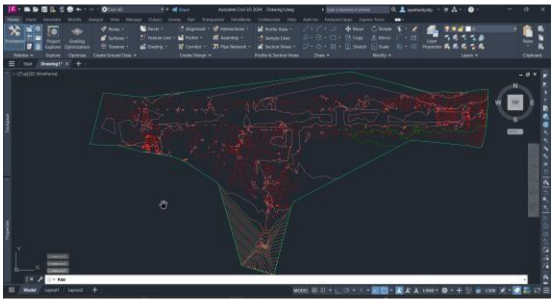

Figure 6 Contour image output

4.3. *Calculation of Excavation and Stockpile Volume*

1. Existing elevation

   The existing elevation of the Runway End Safety Area (RESA) can be determined through topographic data that has been further processed using Autodesk Civil 3D software. The data produced is existing soil elevation data in the form of numbers in meters above sea level at a distance of every 5 meters.

2. Plan elevation

   a. Elongated cut

The longitudinal cut of the Runway End Safety Area (RESA) at the point represented by the letters A\u2012M is 90 meters in size and there are 19 ground elevation points. Each of these points has a distance of 5 meters from the other points. Then the difference in the planned soil elevation can be calculated using the following calculation.

Difference in soil elevation (m) = Percent slope (%) x Distance between points (m)

= 1% x 5 m

= 0.05 m

Based on calculations, it can be seen that for every 5 meters, the Runway End Safety Area (RESA) ground elevation has decreased cumulatively by 0.05 meters (calculated from STA 0+00 or the closest to the runway).

The existing elevation threshold of 12 is 794.375 meters above sea level, so at STA 0+00 the value is the same. Furthermore, STA 0+05 received a decrease of 0.05 m from the point of STA 0+00. The elevation calculation at the next STA point will be the same as before. The following is presented a table of elevation of the longitudinal cut plan at point G as the midpoint of the transverse cut in the following table.

Table 4. Existing elevation and plan

STA	Elevasi Eksisting (mdpl)	Penurunan level dari STA 0+00 (m)	Elevasi Rencana (mdpl)
0+00	794.83	0.00	794.375
0+05	794.77	0.05	794.325
0+10	794.55	0.10	794.275
0+15	794.41	0.15	794.225
0+20	794.58	0.20	794.175
0+25	794.57	0.25	794.125
0+30	794.55	0.30	794.075
0+35	794.51	0.35	794.025
0+40	794.45	0.40	793.975
0+45	794.38	0.45	793.925
0+50	794.32	0.50	793.875
0+55	794.33	0.55	793.825
0+60	794.37	0.60	793.775
0+65	794.47	0.65	793.725
0+70	794.56	0.70	793.675
0+75	794.66	0.75	793.625
0+80	794.62	0.80	793.575
0+85	794.56	0.85	793.525
0+90	794.49	0.90	793.475

b. Transverse cutouts

The crosssection of the Runway End Safety Area (RESA) is 60 meters in size and there are 13 points, each of which is 5 meters apart. Furthermore, the difference in the planned land elevation can be calculated with the calculation below.

Difference in soil elevation (m) = Percent slope (%) x Distance between points (m)

= 2% x 5 m

= 0.1 m

According to the calculation above, it is known that the difference in soil elevation is planned to decrease by 0.1 meters cumulatively (calculated from the G point or the middle point of the transverse cut). The following is presented a table containing the existing elevation and the elevation of the transverse cut plan at STA 0+00 and STA 0+90.

Table 5. Existing elevation and plan

Titik	Penurunan Level	STA 0+00		STA 0+90	
		Elevasi Eksisting	Elevasi Rencana	Elevasi Eksisting	Elevasi Rencana
A	0.6	794.06	793.775	794.31	792.875
B	0.5	794.05	793.875	794.32	792.975
C	0.4	794.04	793.975	794.37	793.075
D	0.3	794.02	794.075	794.43	793.175
E	0.2	794.01	794.175	794.49	793.275
F	0.1	794.72	794.275	794.69	793.375
G	0	794.83	794.375	794.49	793.475
H	0.1	794.75	794.275	794.35	793.375
I	0.2	794.02	794.175	794.21	793.275
J	0.3	794.04	794.075	794.07	793.175
K	0.4	794.07	793.975	794.03	793.075
L	0.5	793.98	793.875	794.01	792.975
M	0.6	793.97	793.775	793.99	792.875

3. Image of RESA cutouts

Cut drawings are made vertically to give an idea of the existing ground surface and the planned ground surface. In this study, transverse cut drawings and longitudinal cut drawings will be made using Autodesk Civil 3D software.

a. Using a pre-made contour plan, a site plan or Runway End Safety Area (RESA) work plan area. Next, make the alignment and profile of the longitudinal cutout, along with the assembly and corridor for the transverse cut.

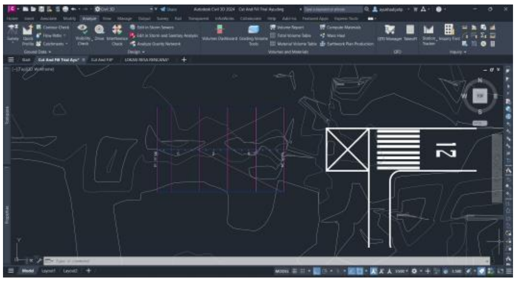

Figure 7 Site plan work area

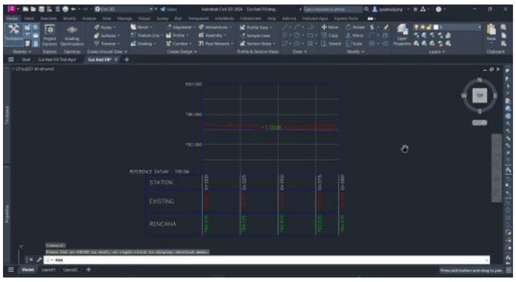

Figure 8 Elongated cut profile

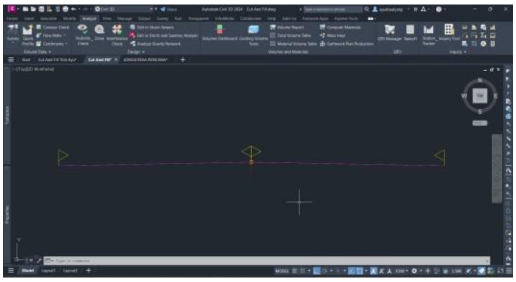

Figure 9 Corridor cross-cut

b. Create a sample line based on the alignment that has been created beforehand. This sample line will later simplify the process of making longitudinal and transverse cut drawings.

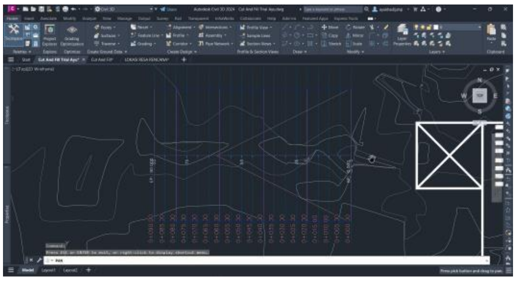

Figure 10 Sample line transverse cut

c. Create section views. Select create multiple views. Click OK when you're done setting it up. Place it on an empty spot to process the creation of the cut image.

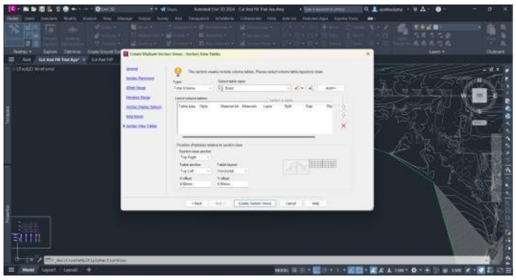

Figure 11 Multiple section view settings

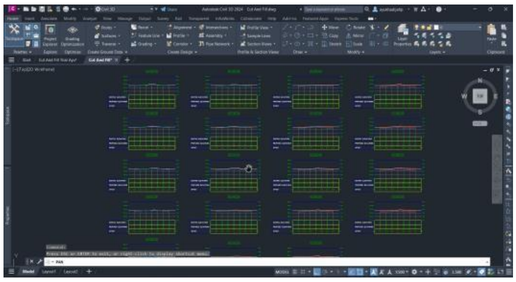

Figure 12 Drawing of a cross cut

4. Volume of excavations and heaps

The calculation of excavation and stockpile volumes is carried out using Autodesk Civil 3D software if it already has existing surface data along with profiles with a planned slope.

a. On the analyze tab, in the volumes and materials section, select compute materials, then a small window will appear, select the alignment and sample line to be calculated volume, click OK. Then edit the material based on the surface to be calculated.

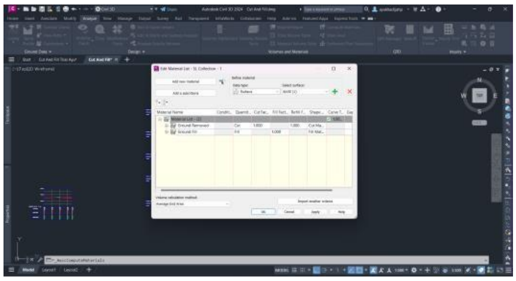

Figure 13 Material list edit window

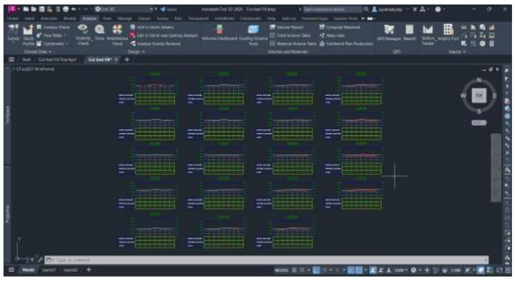

Figure 14 Drawing of a cross cut

b. After the area to be excavated and filled appears, the next step is to reveal the number of areas and volumes of excavations and piles. Right-click on the slice image, select section view group properties, click change volume table, then a new window will appear.

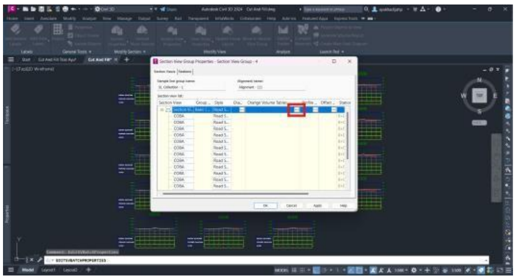

Figure 15 Window section view group properties

c. In the change volume window, set the type to total volume and the table style to default. Then on X the offset is changed to 20. Click apply and OK. Wait for the program to complete the work until a table appears containing data on the area and volume of excavations and piles. Right-click and select update section view layout to tidy up the table position.

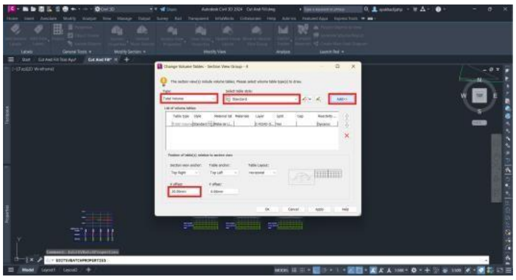

Figure 16 Window change volume tables

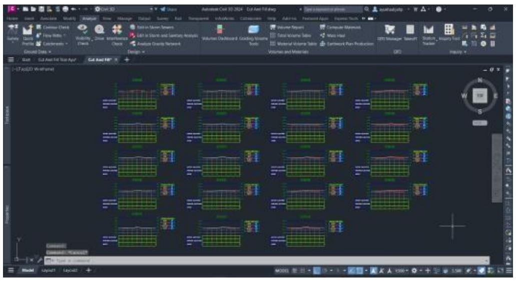

Figure 17 Horizontal cut drawing along with volume table

d. After obtaining a table of the amount of excavation and stockpile volume from the results of the calculation analysis by Civil 3D software, then the total volume can be calculated using the Microsoft excel program. Based on Table 6 below, it can be known for the excavation volume of 3156.48 m3 and the volume of the stockpile of 2.08 m3.

Table 6. Volume value recap

STA	Volume	
	Galian	Timbunan
0+00	0.00	0.00
0+05	13.40	0.29
0+10	65.67	1.26
0+15	65.72	0.53
0+20	76.93	0.00
0+25	95.08	0.00
0+30	114.58	0.00
0+35	137.54	0.00
0+40	156.90	0.00
0+45	168.83	0.00
0+50	180.52	0.00
0+55	196.69	0.00
0+60	212.58	0.00
0+65	228.40	0.00
0+70	247.62	0.00
0+75	270.73	0.00
0+80	291.43	0.00
0+85	307.74	0.00
0+90	326.12	0.00
Total	**3156.48**	**2.08**

4.4. RESA Job Stages

1. Measurement work

   Measurement work is carried out at locations that are within the scope of the Runway End Safety Area (RESA) work for further work preparation as a reference for implementation in the field. Measurement work is carried out by measurement experts with measurement aids. Measurement work includes distance measurement, levelling survey, centerline, as well as data preparation and map creation in accordance with the scope of work of the Runway End Safety Area (RESA), which is 90 x 60 meters.

2. Equipment mobilization and demobilization

   Mobilization and demobilization work consists of the movement of personnel, equipment, materials, and supplies to and from the project site to support the implementation of the work. The mobilization of equipment is completed within a maximum period of 28 days from the date of commencement of work.

3. Occupational Safety and Health Management System (SMK3)

   The Construction Occupational Safety and Health Management System is carried out to control OSH risks in each construction work. SMK3 construction in this work includes K3 socialization, personal protective equipment, insurance and licensing, K3 personnel, health facilities, and necessary signs.

Referring to the Circular Letter of the Minister of PUPR No. 11/SE/M/2019 concerning Technical Instructions for the Cost of Implementing the Construction Safety Management System, personal protective equipment that will be used for Runway End Safety Area (RESA) work is in the form of project helmets, safety glasses, masks, gloves, vests, and safety shoes.

4. Clearing work

   Clearing work includes the work of cleaning the surface of the work area from all kinds of objects and materials such as shrubs, tree roots, wood, debris, and other natural waste. Cleaning is done only on the surface. Unnecessary cleaning results must be removed from the job site immediately.

5. Excavation and stockpile work

   Excavation and piling work is carried out for the purpose of forming a slope according to what has been planned. The volume of excavation and landfill work in this study is planned to be 3156.48 m3 and 2.08 m3 respectively with a longitudinal slope of 1% and a transverse slope of 2%.

   Excavation work will be carried out after the measurement work to obtain information on the planned elevation and slope. The excavated material will be transported and moved to a predetermined disposal area. Some of the excavated materials that are still feasible and meet the technical requirements will be reused to meet the needs of the landfill work.

6. Soil compaction work

   According to ICAO in the Aerodrome Design Manual Part I Doc 9157, soil compaction is carried out to prepare the soil in the Runway End Safety Area (RESA) area so that it has sufficient carrying capacity to avoid damage to the aircraft. This surface is useful for holding the front wheels of the aircraft from sinking too deep.

7. Final landfill work

   The top ground level in the Runway End Safety Area (RESA) area is arranged in such a way as to resist and provide resistance to the skidding wheels of the aircraft. The surface of this final soil embankment is planned to be 10 cm thick from the compacted soil surface. The surface that is not as strong as the surface below serves to help slow down the aircraft's movement.

4.5. Budget of Quantity (BOQ) Calculation

In the implementation of Runway End Safety Area (RESA) work, it requires good planning so that it cannot be separated from the calculation of the Cost Budget Plan (RAB). The cost budget plan in this study is calculated based on the Regulation of the Minister of Transportation No. 78 of 2014 and the 2022 Kerinci Regency Goods and Services Price Standards. The following is a detailed of the Tabel 7. Budget of Quantity (BOQ).

5. CONCLUSION AND SUGGESTION

5.1. Conclusion

Based on the discussion in Chapter IV, it can be concluded as follows.

1. The soil contour of the Runway End Safety Area (RESA) planning land area at threshold 12 of Depati Parbo Kerinci Airport has been drawn according to the coordinate point data that has been measured. Pictures of the situation are attached to Appendix B.
2. The Runway End Safety Area (RESA) at threshold 12 of Depati Parbo Kerinci Airport is planned to have dimensions of 90 x 60 meters, with a percentage of longitudinal slope of 1% and a transverse slope of 2%. Based on the predetermined slope, the volume of excavation and landfill required in the Runway End Safety Area (RESA) planning area at threshold 12 can be calculated using Autodesk Civil 3D software. From the results of the calculation, the excavation volume was 3156.48 m3 and the stockpile volume was 2.08 m3.
3. The results of the analysis and calculation of the Cost Budget Plan (RAB) for the planning of the Runway End Safety Area (RESA) at threshold 12 of Depati Parbo Kerinci Airport, obtained a total cost of Rp668,100,000.00.

5.2. Suggestion

Based on the discussion in Chapter IV, there are suggestions that need to be considered as follows.

1. According to PR 21 of 2023 concerning Technical and Operational Standards of Civil Aviation Safety Regulations, that the Runway End Safety Area (RESA) must be available at each end of the runway strip at each airport, it is better for Depati Parbo Kerinci Airport to immediately realize the Runway End Safety Area (RESA) facility at the end of threshold 12.
2. During the implementation of the Runway End Safety Area (RESA) work, it is expected to be carried out in accordance with carefully calculated planning and always pay attention to worker and

Tabel 7. Budget of Quantity (BOQ)

RENCANA ANGGARAN BIAYA					
Pekerjaan : Pembuatan Runway End Safety Area (RESA)					
Lokasi : Bandar Udara Depati Parbo Kerinci					
NO	**URAIAN PEKERJAAN**	**SATUAN**	**VOLUME**	**HARGA SATUAN (Rp)**	**JUMLAH HARGA (Rp)**
I.	**Pekerjaan Persiapan**				
1	Papan Nama Proyek	Unit	1	Rp 1,033,436.94	Rp 1,033,436.94
2	Direksi Keet	m2	36	Rp 1,249,690.39	Rp 44,988,854.04
3	Pengukuran	m2	5400	Rp 3,254.64	Rp 17,575,045.20
4	Mobilisasi dan Demobilisasi	LS	1	Rp 26,000,000.00	Rp 26,000,000.00
5	SMK3 Konstruksi				
	a. Personil K3	OB	4	Rp 1,500,000.00	Rp 6,000,000.00
	b. Sosialisasi K3	bh	1	Rp 500,000.00	Rp 500,000.00
	c. Alat Pelindung Diri	Paket	10	Rp 470,000.00	Rp 4,700,000.00
	d. Fasilitas Sarana Kesehatan	Paket	1	Rp 1,000,000.00	Rp 1,000,000.00
	e. Rambu-Rambu	Paket	1	Rp 1,200,000.00	Rp 1,200,000.00
				Sub Jumlah Harga Pekerjaan I	**Rp 102,997,336.18**
II.	**Pekerjaan Pembuatan Runway End Safety Area**				
1	Pekerjaan *Clearing*	m2	5400	Rp 13,298.50	Rp 71,811,908.64
2	Pekerjaan Galian Tanah serta Pembuangan	m3	3156.48	Rp 61,096.43	Rp 192,849,669.47
3	Pekerjaan Timbunan Tanah	m3	2.08	Rp 174,930.77	Rp 363,856.01
4	Pekerjaan Pemadatan Tanah	m2	5400	Rp 25,829.27	Rp 139,478,045.04
5	Pekerjaan Penimbunan Tanah Akhir	m3	540	Rp 174,930.77	Rp 94,462,617.47
				Sub Jumlah Harga Pekerjaan II	**Rp 498,966,096.63**
(A) Jumlah Harga Pekerjaan I dan II					**Rp 601,963,432.81**
(B) Pajak Pertambahan Nilai (PPN) = 11% x (A)					**Rp 66,215,977.61**
(C) Jumlah Total Harga Pekerjaan = (A) + (B)					**Rp 668,179,410.42**
(D) Jumlah Total Harga Pekerjaan Dibulatkan					**Rp 668,100,000.00**
Terbilang	*Enam Ratus Enam Puluh Delapan Juta Seratus Ribu Rupiah*				

environmental safety procedures in its implementation.

3. Before the implementation of the work, it is necessary to carry out more careful and detailed measurements and surveys in order to obtain more accurate data according to the existing conditions at that time.
4. For further research, it is hoped that it will be able to use the latest Kerinci area wage unit price standards and materials and conduct a final test on the condition of soil materials in the Runway End Safety Area (RESA) work area related to soil strength and carrying capacity.

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