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Planning Reactivation Train for Kedungjati – Tuntang Using Google Earth, Global Mapper, and AutoCAD Civil 3D

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***Abstract*—Kedungjati - completion road is a railway line that has not been used, and it used to connect between Semarang and Secang, Magelang Regency. In accordance, with the 2011 National Railway Master Plan (RIPNAS), the Directorate General of Railways of the Ministry of Transportation stated that the need for by development of development areas and railway services in Indonesia. The Kedungjati - Tuntang Railway is a route from Semarang to the National Tourism Strategic Area (KSPN) of Borobudur Temple so that the route needs to be reactivated. The software that will be used is Google Earth, Global Mapper, and the Civil 3D AutoCAD. The software is easy to apply, accurate and structured to plan reactivation of the railway. The method that will be used is to run all three software with sequential work systems from Google Earth, Global Mapper, and 3D Civil AutoCAD in a structured manner. The data obtained from the planning results are the plan speed of 112.5 km/h, minimum radius of 440 m, 99 m transition curve, 30.6 km track length, 25 per mile maximum slope, maximum 110 mm rail elevation, and rail elevation minimum of 60.46 mm.**

Keywords: Google Earth, Global Mapper, 3D Civil AutoCAD, horizontal alignment, vertical alignment, Kedungjati - Tuntang Railway

I. Introduction

Kedungjati railroad railway line is a railway line that is dead or inoperative, once this line connected between Semarang and Secang in Magelang Regency. The line, built by the Nederlands Indische Spoorweg Maatschappij (NISM) in 1871 and completed in 1905, passed three stations, namely: Tempuran Station, Gogodalem Station, and Bringin Station and Ngombak and Tlogo Shelters which used to be used as loading and unloading timber.

In 1970, Tuntang Station was also used as cattle transportation to be transported to Jakarta, the lack of service and the development of the train at that time made the people choose highways such as national and toll roads because it was considered safer, more efficient and faster. In 1976 the Kedungjati - Tuntang railway was officially closed. Because it was unable to compete with existing modes of transportation on the highway, for 40 years the line was not activated, and the components of the upper structure of the railroad were still visible.

In accordance with the 2011 National Railroad Master Plan (RIPNAS), the Directorate General of Railways of the Ministry of Transportation explained that the target of the railway network and service development to be achieved by 2030 is one of which is 12.100 km of the national railroad (spread on Java, Bali, Sumatra, Sulawesi, Kalimantan, and Papua) [1]. It is planned to be able to serve passenger travel of 929.5 million people/year, including passenger trips in 15 urban areas and goods, with a total of 995.5 million tons/year.

Reactivation needs to be done on the Kedungjati-Tuntang route intended to reactivate the Semarang-Magelang railway line which will be the link between Ambarawa, Jogjakarta, and Magelang where there are tourist attractions of Borobudur Temple. Borobudur Temple will be a priority for access to the National Tourism Strategic Area (KSPN) combined with the National Railway Master Plan (RIPNAS) in 2011.

II. Research Method

The basis of the author in completing this study is as follows:

- PM No. 60 of 2012 concerning the technical requirements of the Railroad Line [2]
- Service Regulation No.10 of 1986 as a reference in planning railroad structural components

Informing and completing this study, literature is needed regarding railways, railroad planning, railroad reactivation, and Ministry of Transportation regulations.

TABLE I. TYPES AND FUNCTIONS OF SUPPORTING DATA

Data Type	Data function
Long Section	As a basis for planning railways that will be activated
Output data Google	Knowing earth and global height of surface Mapper surface elevation and basic contour of geometric planning of railroad
Field survey results	Documentation

Based on TABLE I, route planning does not need to be done because the cycle uses existing or inactive railroad tracks, so the geometry calculations used include [3]:

1) Horizontal alignment: curved circles, transitional arches, train width, and elevation.

2) Vertical alignment: positive and negative curvatures, and calculation of the height of each STA.

After obtaining vertical alignment data and structural details, it will be used to create cross-sectional images of each STA, which is then used to calculate the excavation volume and heap.

III. RESULTS AND DISCUSSION

The stages of analysis included making contours using the Google Earth and Global Mapper applications, determining design criteria, horizontal and vertical curvature improvements from the obtained data traces, making longitudinal and transverse pieces and pile excavation volumes and mass haul diagrams [4].

A. *Land Contour*

This location pin in Google Earth (based on Fig. 1) serves to give a starting point and endpoint for the Kedungjati - Tuntang reactivation path planning at Kedungjati Station and ends at Tuning Station.

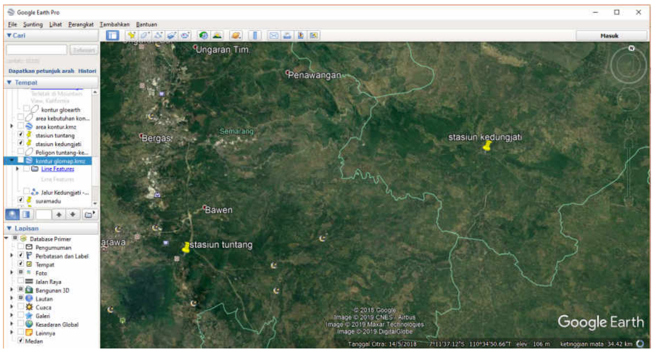

Fig. 1. Pin Location.

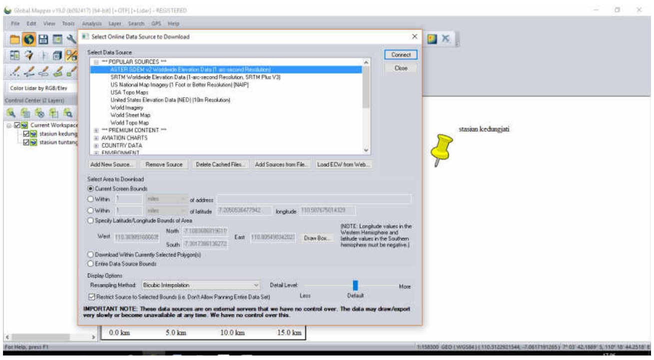

Fig. 2. Import to Global Mapper.

In this global Mapper application in Fig. 2, locations that have been marked on Google Earth will be imported and linked to the actual condition map so that the land contour will automatically be found. This land contour will be saved to DEM format so that it can be opened in the Civil 3D application.

Then open the Civil 3D application (Fig. 3), select the setting drawing, then set the zone category according to the location to be studied, UTM WGS84 Datum, then select the coordinate system UTM - WGS84, zone 49 south, meter, cent, meridian 111d. After setting the zone and coordinates then return to the prospector right-click surface create a surface from DEM then click where the automatic contour (Fig. 4) will appear. The sit long data plot that has been obtained on the contour.

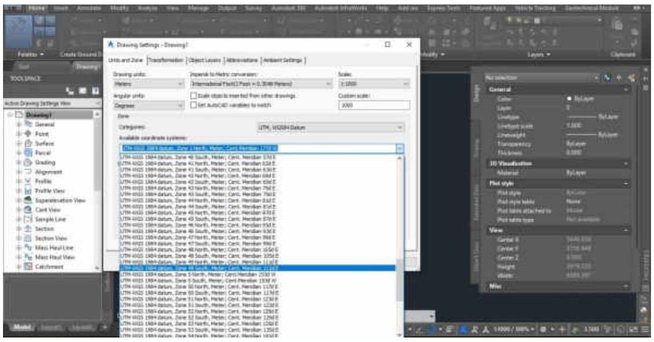

Fig. 3. Import Contour Civil 3D.

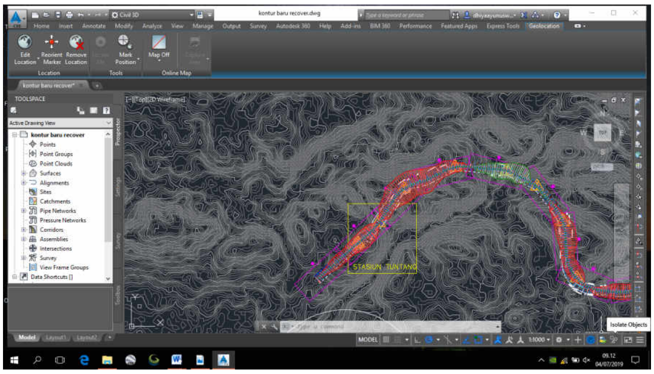

Fig. 4. Contour.

B. *Design Criteria*

In alignment properties in Fig. 5, there are several tabs. The information tab can be selected by rail because the design that will be made is the railway. In this type, there is another menu that can be chosen to design in addition to the railroad, namely the highway.

The station control in the Fig. 6 tab contains information about the X and Y coordinate reference points and stations. Station 0 + 000.00 is the initial station which is in coordinates X = 439222.2973 and Y = 9197502.0802. Then there is information on the length of the rail design which is 15946.624 m with a start 0 + 000.00 m and end 15+946.62 m.

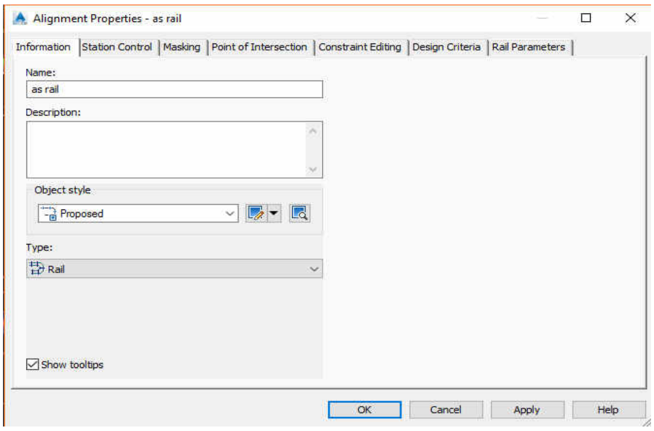

Fig. 5. Alignment Properties.

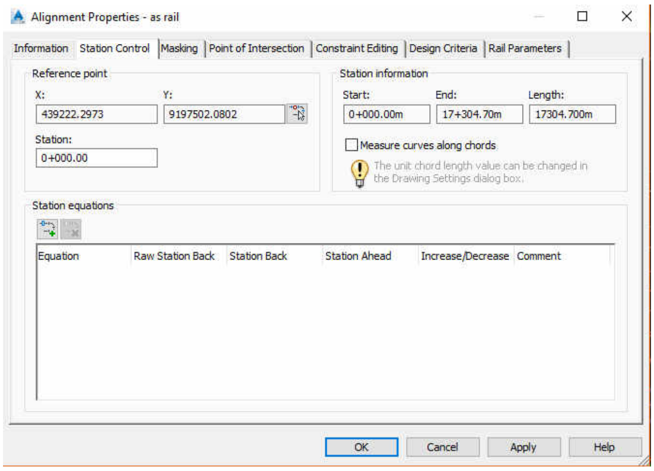

Fig. 6. Station Control.

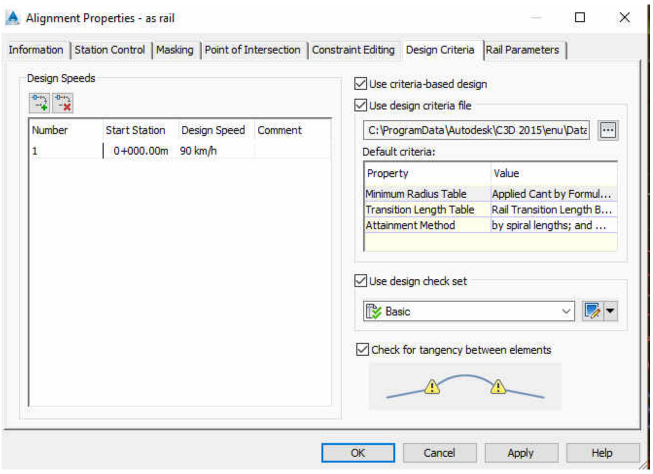

Fig. 7. Design Criteria.

According to the road class classification [2], the maximum speed used for road class 4 is 90 km/h, then the design criteria include a speed of 90 km/hr (Fig. 7). Then to find out whether the curve to be made is a problem or not the check for tangency between elements box is checked.

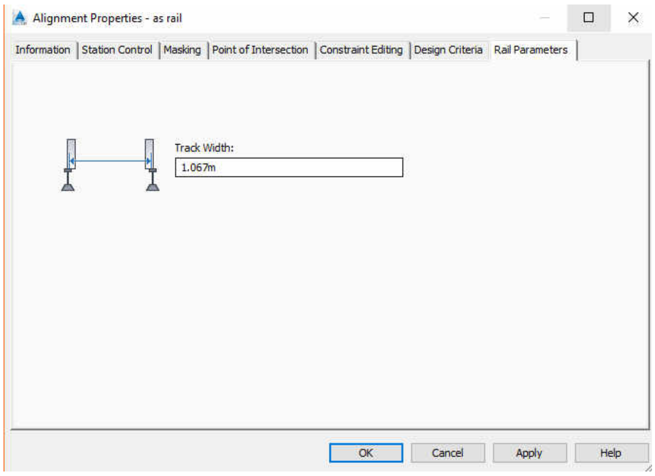

Fig. 8. Rail Parameter.

In this section, the researcher can determine the width of the railway to be used in the plan, which is 1067 m. In this subassembly properties, it is complete rail parameters ranging like Fig. and Fig. 9 from the slope of the rail, the width of bearing, bearing width, bearing height, ballast width, ballast depth, ballast slope, sub-ballast width, sub-ballast depth, and sub slope reply. Can be filled according to road class 4 planning [2] for 1: 2 ballast slope and ballast sub slope 1: 1.5. Sepur width is 1067 m, bearing width 2 m, ballast width 1.9 m, width sub-ballast 3 m.

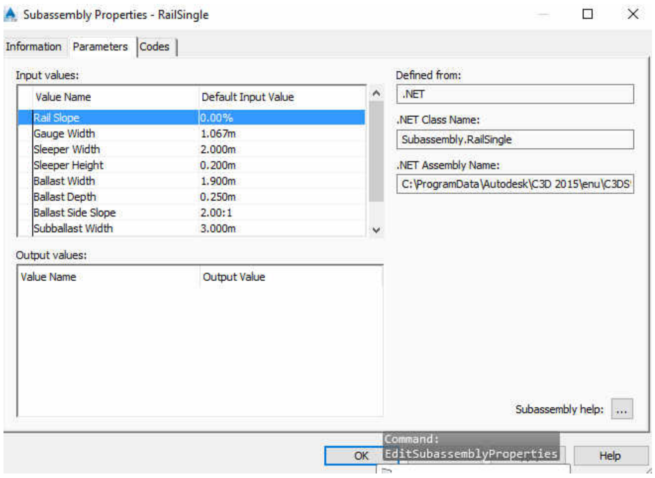

Fig. 9. Subassembly Properties.

C. *Alignment Horizontal*

Based on the data received by the researcher, the horizontal alignment of the Kedungjati-Tuntang tract has 25 curves that must be repaired if using road class 4 specifications [2]. For the arch types used are spiral-circle-spiral and spiral-spiral (full circle).

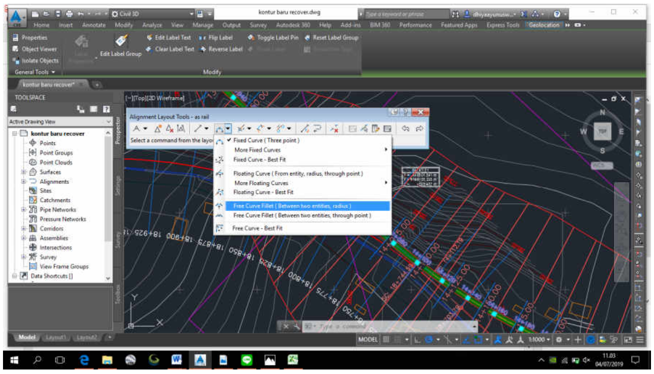

Fig. 10. FC Curve Repair.

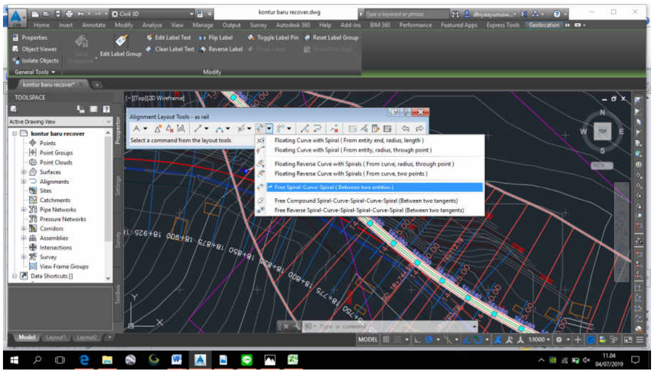

Fig. 11. SCS Curve Repair.

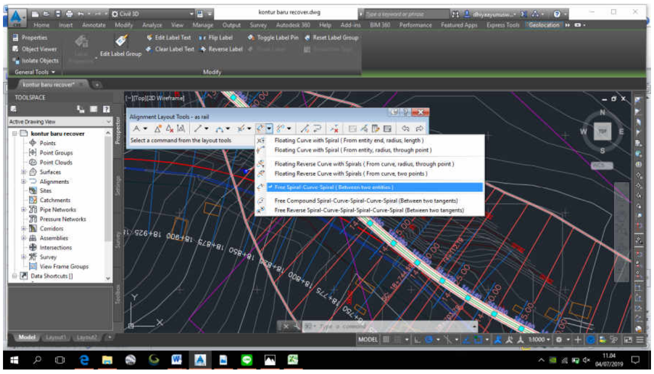

Fig. 12. Alignment Horizontal.

Before redesigning using the civil 3D application liked Fig. 10, Fig. 11 and Fig. 12, a manual calculation was performed to correct the curvature that had R less than 440 m with the transition and 1330 m without the intermediate curve. After the numerical calculation is obtained, it can be inputted using the Civil 3D application, and then automatically a curved repair will appear.

D. Alignment Vertical

Vertical alignment on the second phase - the improvement has also been improved for class 4 class classification [2], the maximum allowed slope is 25‰. Vertical alignment planning (TABLE II) in the civil 3D application starts with the starting point STA 0 + 000.00 with the initial elevation 491.658 m and STA 4 + 300 elevations 475,000 m liked Fig. 13. Based on the TABLE III, the slope between these two points is 2.3‰ under the provisions of 25‰ and between STA 4+300 to STA 9+800 has a slope of 22.7‰.

TABLE II. VERTICAL ALIGNMENT CALCULATION

No.	PVI Station	PVI Elevation	Grade In	Grade Out
1.	0+000	491,658		2,3‰
2.	4+300	475,000	22,7‰	

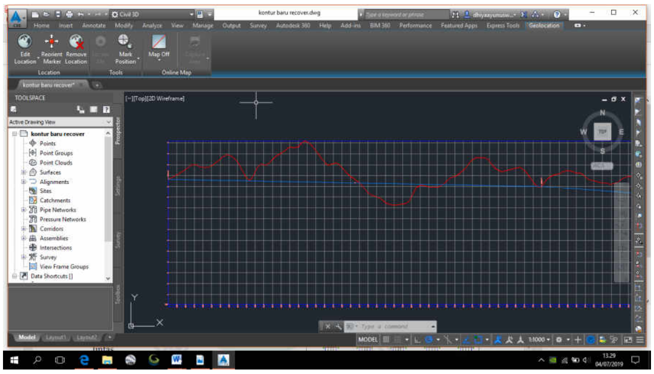

Fig. 13. Alignment Vertical STA 0+000 until STA 4+300.

E. Crossing the Cross

On the cross-section in Fig. 14 and Fig. 15 of the railroad can be seen the structure of the railroad is divided into two parts, namely the upper structure and the lower structure.

1) *The upper structure (superstructure)*: rail, bearing, tethering, and wesel.

2) *The bottom structure (substructure)*: reply, sub replied, basic land, and natural land.

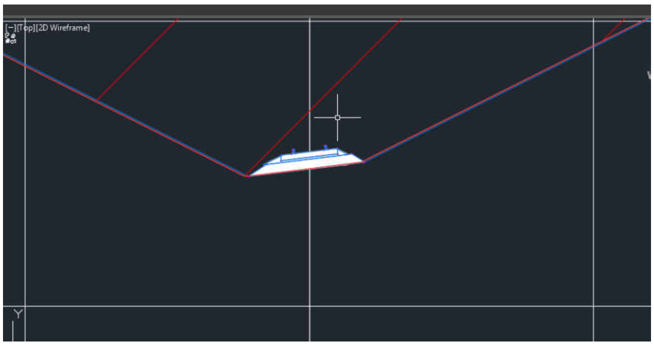

Fig. 14. STA Crossing Examples.

F. Minerals and Stacks Volume

Excavations and heaps are a very important part of the work in the construction of railroads [5]. Then a detailed calculation is needed so that the planned volume of excavation and stockpiles is by the conditions in the field and does not create a budget of high costs. With the civil 3D application, researchers try to display the area count of one cross-section and the volume between two adjacent cross-sections. The distance between the STA that is made is 25 m so that it is expected to obtain the volume of land that approaches the original conditions in the field.

From all the cross-sections that have been calculated, the cumulative excavation is 26126671.62 m^3, and the cumulative heap is 842906.91 m^3 so that the figure can indicate that the site requires a lot of excavated land.

G. Mass Haul Diagram

Mass Haul Diagrams (MHDs) are used to compare the economics of various methods of distribution of earthworks on-road or railroad construction schemes [6]. With the combined use of mass haul diagrams plotted directly under the longitudinal part of the survey centerline, it can be found the distance at which the excavation and heap will be balanced. The amount of material moved and directed of movement. Areas where land may have to be stockpiled or excavated and the amount involved. The best policies can be taken to get the most economical use of the plan.

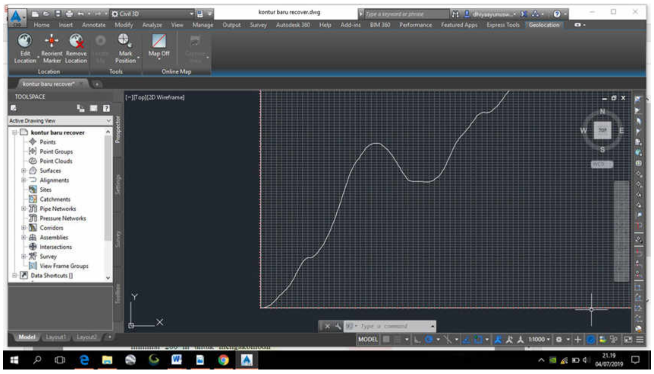

Fig. 16. Mass Haul Diagram.

Fig. 16 shows that the excavation work is on a rising curve, and the curve area decreases for embankment work.

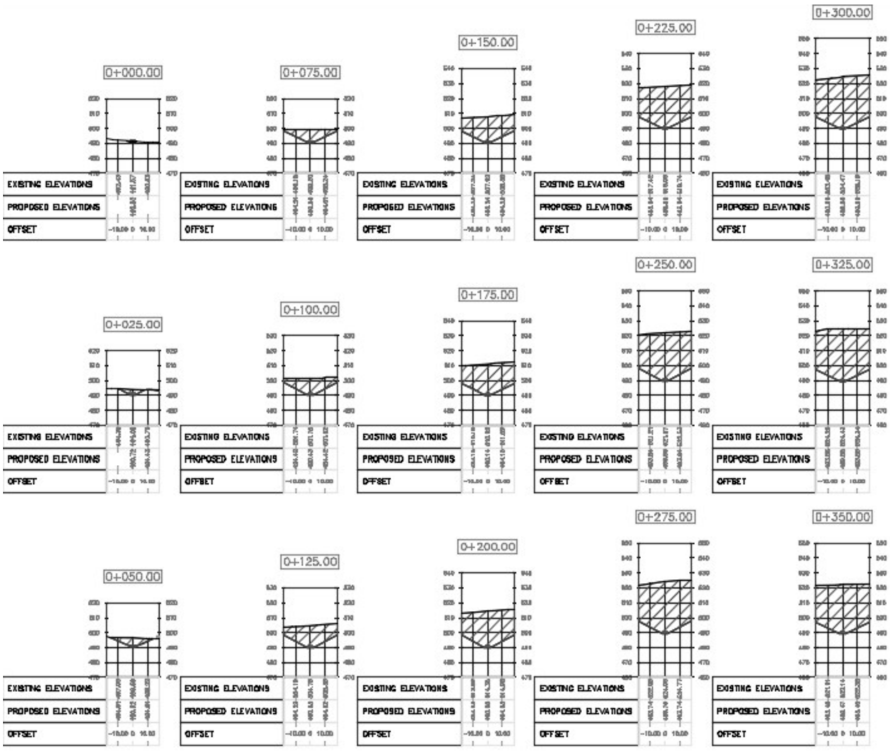

Fig. 15. TA cross-section to STA.

TABLE III. CALCULATION OF EXCAVATION AND STOCKS EVERY 25 M

Total Volume Table						
Station	**Fill Area**	**Cut Area**	**Fill Volume**	**Cut Volume**	**Cumulative Fill Volume**	**Cumulative Cut Volume**
0+000.00	0.00	0.00	0.00	0.00	0.00	0.00
0+025.00	1.83	37.16	22.84	464.55	22.84	464.55
0+050.00	2.22	96.43	50.58	1669.93	73.43	2134.48
0+075.00	0.00	185.09	27.74	3518.99	101.17	5653.47
0+100.00	0.00	281.63	0.00	5833.92	101.17	11487.39
0+125.00	0.00	392.94	0.00	8432.08	101.17	19919.47
0+150.00	0.00	508.41	0.00	11266.89	101.17	31186.35
0+175.00	0.00	618.84	0.00	14090.59	101.17	45276.94
0+200.00	0.00	745.26	0.00	17051.19	101.17	62328.13
0+225.00	0.00	884.99	0.00	20378.07	101.17	82706.20
0+250.00	0.00	1023.66	0.00	23858.12	101.17	106564.32
0+275.00	0.00	1098.21	0.00	26523.40	101.17	133087.71

Total Volume Table						
Station	**Fill Area**	**Cut Area**	**Fill Volume**	**Cut Volume**	**Cumulative Fill Volume**	**Cumulative Cut Volume**
0+300.00	0.00	1120.76	0.00	27737.16	101.17	160824.88
0+325.00	0.00	1119.76	0.00	28008.58	101.17	188831.43
0+350.00	0.00	1048.46	0.00	27106.49	101.17	215937.92
0+375.00	0.00	979.43	0.00	25352.32	101.17	241290.24
0+400.00	0.00	940.37	0.00	23997.41	101.17	265287.65
0+425.00	0.00	944.96	0.00	23566.59	101.17	288854.24
0+450.00	0.00	955.50	0.00	23755.76	101.17	312610.00
0+475.00	0.00	1001.83	0.00	24466.65	101.17	337076.65

IV. CONCLUSIONS

The research conducted can be summarized as follows:

1. Horizontal alignment consists of 25 curves that must be corrected for the curvature used, namely spiral-circle-spiral and spiral-spiral (full circle). A manual calculation is performed to correct the curvature that has R less than 440 m with the transition and 1330 m without the intermediate curve.
2. Vertical alignment is improved with a maximum allowed slope of 25 ‰. Vertical alignment planning in the civil 3D application starts with the starting point STA 0 + 000.00 with the initial elevation 491,658 m and STA 4 + 300 elevations 475,000 m. The slope between these two points is 0.39 ‰ under the provisions of 25 ‰ and between STA 4+300 to STA 9+800 has a slope of 22,7 ‰. With the civil 3D application, researchers try to display the area count of one cross-section and the volume between two adjacent cross-sections. The distance between the STA that is made is 25 m so that it is expected to obtain the volume of land that approaches the original conditions in the field.
3. From all the cross-sections that have been calculated, the cumulative excavation is 26,126,671.62 m^3, and the cumulative heap is 842,906.91 m^3 so that the figure can indicate that the site requires a lot of excavated land.

REFERENCES

[1] Republic of Indonesia. 2018. Decree of Minister Transportation Republic of Indonesia number KP 2128 of 2018 concerning the Master Plan of the National Railway (in Indonesian). Jakarta: Ministry of Transportation, 2018.

[2] Republic of Indonesia. Regulation of Minister Transportation number 60 of 2012 concerning the Technical Requirements of Railroad Lines (in Indonesian). Jakarta: Ministry of Transportation, 2012.

[3] Mughni, M and Chasanah, F., Planning of the Reactivation Jogja – Parangtritis Railroad Route (in Indonesian). Civil Engineering Journal and UII Planning. Yogyakarta, 2013.

[4] Aghastya Adya, Tamtomo Wahyu A. API Madiun Outer Ring Toll Planning Uses Autocad Civil 3D (in Indonesian). Indonesian Railways Journal Vol. 1 No. 2 ISSN 2550-1127, 2017.

[5] Rosyidi, Sri Atmaja P. Dictates on Railroad Structure Engineering (in Indonesian). http://atmaja.staff.umy.ac.id/files/2012/03/BAB-X-PERENC-GEOMETRIK-JALAN-REL.pdf. 2018. Downloaded on Augst, 3th 2019.

[6] Slideshare. Topic 3 Mass Haul Diagram (in Indonesian). https://www.slideshare.net/kmasz/topic-3-mass-haul-diagram, 2011. Downloaded on July, 4th 2019.