



Project from Basic Railway Planning and design (Group 1)

RAW BS1, A08, VIA UC

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1 Introduction

This is the main project of Railway Planning and Design class in VIA University College, Denmark, Horsens. The teachers are Martin Moth-Lund, Niels Henrik Kjar Jensen; Steffen Hartig.

The project consist of 3 parts. First Open line design ,the second depot area and the last, cantenary system. In the first task we had to upgrated the speed . In depot area we had to design a small depot and in the last we designed cantenary system.

Our tasks working involved such as phases as calculation ,sketches and drawings

For making drawings we use such software as AutoCAD while all calculations were done using spreadsheet in OpenOffice.org

All solutions within these project are made according to course materials, personal experience and knowledge.

2 Open Line Design

2.1 *Description Task*

In this part of our project, our job was to rise allowed trains speed from 70 km/h to 80 km/h according to condition:

- $10 \text{ mm} \leq \text{cant} \leq 150 \text{ mm}$, cant has to be a multiple of 5mm
- $\text{yerk} \leq 55 \text{ mm/s}$
- Ramp speed: $\leq 50 \text{ mm/s}$
- Relative ramp gradient: 0,2%
- Length of each curve length (curve, transition curve and straight line): $L \geq V/4$
- $I \leq 100 \text{ mm}$

2.2 *Main problem.*

Main problem was checking by what (jakies modre slowo wstawic) you can achieved targeted speed. Also we should think about the most reasonable, economical and safer

solution. We must also think about time and money needed for rebuild line to desire speed.

2.3 Problem solving.

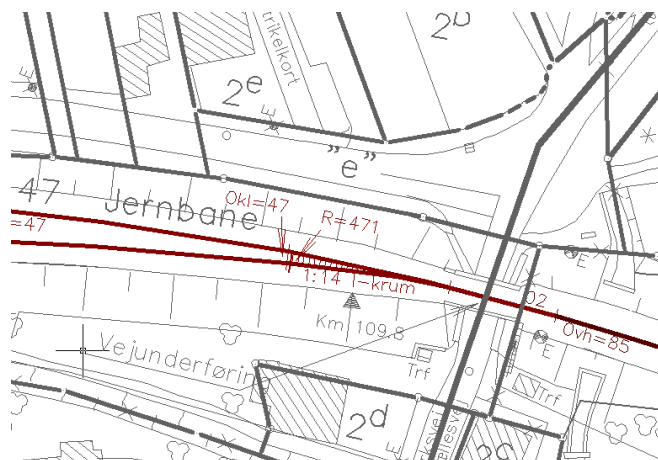
First step was to write down all data about curves.

Using equation: $C_{ideal} = \frac{11,8 \cdot V^2}{R}$ we calculate ideal cant for all curves for speed 80km/H. Because in Denmark difference between existing cant and ideal cant is maximum 100, we calculate minimal cant on each curve. $C_{min} = C_{ideal} - 100$. According to minimal cant and fact that cant cannot be bigger than 150 we chose cant for each curve C . After choosing cant we were able to know our real difference between ideal cant and chosen.

After choosing a cant we calculate minimal length of transitional curve in two relations. First was in relation of speed, and second one in relation of jerk.

As you can see in table on drawing 1.1 and 1.2 all, beside right transition curve of curve number 5, are OK, and we don't have to change them.

We also decided to not change the length of transition curve on curve number 5. For better understanding our statement important is location of this transitional curve. You can see it on



As you can see this transition curve is next to turn out, very close. Every changes made to this transitional curve and curve geometry, would also have effects on this turnout and second lane. Also the way of the how this drawings are made, complicated the possible solution that we can present. Because every curve and transition curve is made from longer or shorter arch elements, we are also luck of turn angel of lines from which the curve was calculated – it's difficult to correct it. Also the difference 3m, in our opinion, it's small difference that we can left it how it is, and max cant change speed is higher only 6%. And we show on the next points, that only this one parameter is a little bigger then it should by.

Next step was to check the Yerk and ramp speed. Last thing to check is minimal length of arch elements like: curve, transition curve. They cannot by smaller than 20m.

3 Depot Track Design

3.1 Description of Task

In this project, our task was to design a depot track for two trains with a length of 50 meters each. The parking places should be designed so, that the trains do not block each others way. The design place is situated at the station 109+500. At this part of the original track an old loading track is present after the turnout S1, as seen on the **drawing number 2_0**.

Additional parameters were the use of unbent turnouts, the minimal radius of at least 190m was also given. The minimal distance between new tracks must be at least 4.0 m.

3.2 Main Problems

Examining the designing area the main issue was the lack of free space. Nearby roads are also present as seen on drawing 2_0. Therefore we had to minimize the space needs of the depot area by finding a simple but yet proper functional solution. So our main principals during the designing were geometry with low space needs. On the following pages we are going to present our ideas and pre-designs before presenting the final solution.

3.3 Problem Solving

a) Solution Nr. 1.

By examining the task and the future needs, our first thoughts were to design two parallel track with a minimum length of 50 meters, connected to each other with three turnouts and which connect the depot area to the track number 3 and 1. (**see drawing number 2_1!**)

At this solution we converted the loading track (track 3) to one of the depot tracks. For connecting the two tracks (track 3 and 4) we used the turnout type of 14, due to its small radius size, to keep space needs low. After connecting the two tracks together with turnout number S4 and examining the spacing between track 3 and 4, we found that trains would block each others way. Thus this solution will not work!

Another issue in this case was that the depot tracks are bent. This situation is not ideal for parking trains with such low length.

b) Solution Nr. 2.

According to the consequences from the previous solution, we were up to leave the turnout at the end of the depot tracks, to get more space to use for parking. This means the designing of two dead end tracks with stoppers at the end. As a disadvantage the trains have two reverse at this case from the depot tracks to the track beneath the turnout S1 and only after this they can move on to track 1.

By choosing this solution we were up to design station areas for both tracks. (**See drawing number 2_2!**) . According to standards the minimum distance between the edge of the station and the track's centerline is 1.5 m. For a comfortable but yet minimal width we used 4m for the stations.

Examining this solution the track number 4, with its station (Station2) would need additional space from the adjacent dam. This is because of the bigger length of track 4, due to the use of a curve after the turnout S3. The curve has to be used to ensure the needed space between the two parking tracks. Although we used the minimal radius

allowed for the curve, we ran out of space at this solution also. Consequence is, that the use of stations can not be allowed without using additional space.

c) **Solution Nr. 3.**

By so far, we were up to simplify the depot track on only one turnout and two tracks with dead ends, without using any station area. **See drawing 2_3_final!**

To save space a turnout has to be put in right after the turnout number S1. Our choice fell on the turnout type nr. 12, because of its small radius size which means small space – use. But still a modern turnout, which means the ability to built on concrete sleepers. This would allow if redesigning all the turnouts to concrete sleepers and renewing the track, to leave the depot station at its original state.

After the turnout S3 was put in, track number 3 was designed, which serves as the first depot track. Therefore its minimal length is 50 m, but using a stopper at the end, makes us to design 10 meters additional length, so the overall track became 60m long. For assuring the parking of trains this whole section is a straight line. Examining the space needs from the original track (track1), it meets the requirements.

For the parallel track (Track 4) a distance of 5 m was used. This could be only ensured with the use of a small straight section after the turnout and then a curve with the radius of 200m. After this curve the needed straight section could be put in for parking trains.



Figure 1: Stopper

At this case the use of a stopper is a must to prevent trains from running out to track 1. A possible type of stopper is shown on Fig.1.

3.4 Conclusion

Solving this task, the main issues, as mentioned before, were space needs. Especially using turnouts to design station areas, or parking tracks, these space-needs have to be considered first and foremost. At this project it was clear to see from the beginning that our usable space is very limited, so we had to design a simple and small depot track to fit in.

At an ideal situation for instance designing a completely new track on an empty and big area, more sophisticated solutions could be used.

4 Cantenary System

4.1 Introduction

In this part, from the track lay out we have to get a cantenary system. Moreover, if we upgrade speed we have to take care of the cantenary system too because it also must be modified if we have different radius. In our project, we chose a piece of line (1,6 Km) without modifications of radius because it is easier like this.

4.2 Main problems

The first thing to do is to make a table of spacing between masts as a function of horizontal radius of the track. After, we have to use the table to position masts along our track in the project (1,6 Km). We have also to check that the maximum difference in spacing is 15 m. Besides, we have to study the case where the contact wire has just passed the bridge. The contact wire height is then 5000 mm. The goal of this work is to restore the contact wire height as possible as 5500 mm.

4.3 Problem solving

To find the space between the masts we used the graph « stagger 250 mm ». When you know the horizontal radius on the railway line you can find the distance with the help of the graph.

After for the schematic drawing it is important to know the difference between the curves and the straight lines. In a curve the masts have to be outside of the curve and the stagger is 250 mm. For a straight line, the stagger is only +/- 200 mm.

We chose the 1,6 Km section from the radius 8 to the radius 12 for the project. We have only two times straight lines : between the radius 8 and 9, and between the radius 9 and 10.

When we have a straight line, we must change the way of the contact wire between two masts all the time. For the curve the contact wire stays on the same place.

Finally, it is important do not forget to put every 800 meters some cable on the masts to keep the tension in the wire. Besides, we have to check the spacing between two masts because the difference is maximum 15 meter. That's why sometime there are some modifications between the values in the table and on the schematic drawing.

Tables to find the space between masts in function of the radius

Radius Number	Transition C. Left	Horizontal Radius	Curve Length	Transition C. Right	Sum	Space Between Masts (m)
R8	90	383	260	90	440	38
R9	100	398	149	100	349	40,5
R10	90	508	120	102	312	45,5
R11	98	455	55	72	225	43
R12	64	467	44	70	178	43,5

Moreover, we have to find as quicker as possible how to low the contact wire from 5,50 meter to 5,00 meter to be able for the train to pass Under the bridge. For that we

used the table with the different gradient and we decided to have a bridge of 10 meters wide.

Table with the different gradients in function of the speed of the train

Speed up to Km/hr	Maximum Gradient per thousand	Maximum change in gradient per thousand
10	60	30
30	40	20
60	20	10
70	16,5	8,25
100	6	3

The method is : $5000 + \frac{8,25}{1000} \cdot 2 \cdot X + \frac{16,5}{1000} \cdot Y = 5500$

So we found for $X = 8\text{m}$ and $Y = 22\text{m}$.

It was possible to find other results but this one is the best because it respects also the 15 meters maximum between two masts.