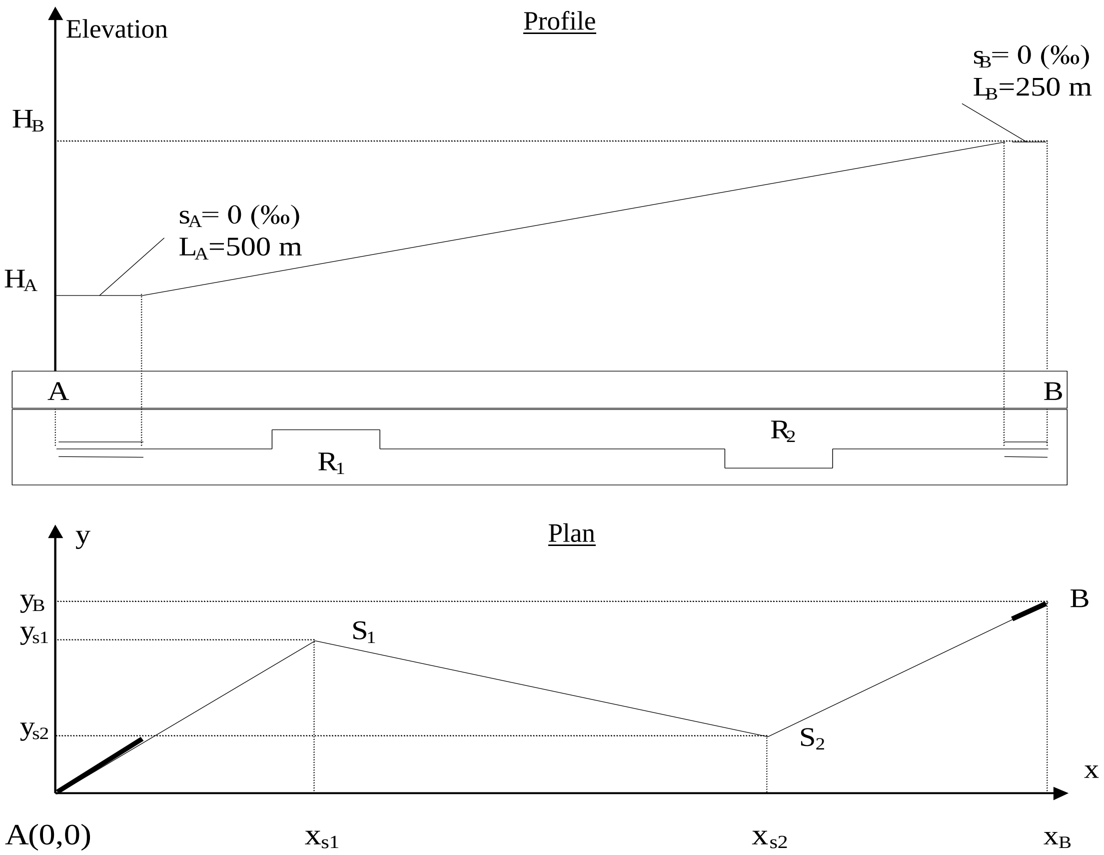
YILDIZ TECHNICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
TRANSPORTATION DIVISION

INS3442 Railway Engineering (2023-2024): Assignment-1 Information Sheet (Railways)



An existing railway line is going to be upgraded according to the new design standards. The schematic profile depicting the grade (red) line and the schematic plan depicting the alignment centerline between station A and station B are given in the figure above. This railway line will be design based on the “principle of constant resistance”. Essential measures (variables and parameters) to be considered in the design and information associated with railway vehicles to be operated are summarized in the following tables.

It is your duty to prepare the design project for upgrading the rail section between A and B and to determine the running conditions for the railway vehicles.

	Unit	Value		Unit	Value
H_A	m	$100 + 100*\mathbf{b}$	H_B	m	$300+110*\mathbf{b}+16*\mathbf{a}$
x_A	m	0	x_B	m	$30000+2100*\mathbf{d}$
y_A	m	0	y_B	m	7500
x_{S1}	m	8000	x_{S2}	m	$23000 - 800*\mathbf{b}$
y_{S1}	m	$3500 + 300*\mathbf{a}$	y_{S2}	m	$3500 - 300*\mathbf{a}$
R_1	m	$800 + 50*\mathbf{a}$	R_2	m	$3500 - 200*\mathbf{a}$

	Unit	Value
Design speed	km/h	$150 + 5*\mathbf{a}$
Transverse (comfort) accell.	m/s^2	$(\mathbf{a} + 16) / 25$
Max. superelev.	mm	150
Superelevation (cant) excess (Δd_f)	mm	90
μ_y (rail-wheel)	N/kN	$(160 + \frac{7500}{V+44})$
μ_f (brk.shoe-wheel)	N/kN	12500/(50+V)

	Unit	Value
α/ β/ γ	---	0.7 / 0.9 / 1.0
Curve resistance	N/kN	650 / (R - 55)
Station slope	‰	0
Accel. of gravity	m/s^2	10
Passenger weight	kg	70

	Unit	PASSENGER	FREIGHT
Max. train weight (total)	gross ton	$250 + 15*\mathbf{c}$	$1000 + 20*\mathbf{b}$
Max. (regime) velocity	km/h	V_{pr} - 50	$70 + 2*\mathbf{b}$
Loco. (Powered unit) type	-----	B_o’ B_o’	C_o’ C_o’
Loco. (Pow. unit) power	kW	$1500 + 50*\mathbf{c}$	$3000 + 50*\mathbf{b}$
Loco. (Pow. unit) weight	ton	60 (tare)	120
Loco. (Pow. unit) length	m	24	24
Max. Pow. unit capacity	passenger	40	----
Wagon tare weight	ton	28	12
Max. wagon capacity	passenger-net ton	60	21
Wagon length	m	22	12.5
Coeff. of train mass increa.	----	1.06	1.06
Rolling (run.) resistance	N/kN	$1.\mathbf{b}+ (V^2/4000)$	$2.\mathbf{a}+ (V^2/3000)$
Traffic amount	pass.-ton/year-direc.	$5*10^6$	$6*10^6$
Average journey length	km	100	300
Total service distance	km	500	500
Max. traffic / Ave. traffic	---	1.2	1.2
Coeff. of train util. rate	---	1.0	0.9
Coeff. of wagon util. rate	---	0.8	0.8

NOTES: **i**. Use two digits after the decimal point for the results at each calculation steps, round off the second decimal place based on the third decimal place.
ii. An assignment number is given to each student **with respect to the group number** registered.

<u>1st PART</u>

1. Calculating the minimum curve radius based on new design speed (for the sake of application ease, the minimum curve radius is rounded up to an integer value having 50 or 00 in the last two digits);
2. Increasing the radii for the curves in need of upgrading and calculating the length of the new alignment;
3. Calculating the new applied gradient, because a 2000-meter long horizontal/level track (which is called “palye” in Turkish) is going to be designed and constructed immediately after the exit of station A (**Average gradient and losses of elevation must be computed by including the stations and horizontal/level track -palye- section.**);
4. Calculating the grade (red) levels of the tangent points of horizontal curves on the track designed by using the principle of constant resistance;
5. Making up passenger and freight (goods) trains based on the maximum train weights given on the Table (determining the number of passenger wagons and freight wagons). (In the beginning, 1 (one) self-powered vehicle and 1 (one) locomotive will be used);
6. Calculating the maximum longitudinal gradients for <u>fully loaded</u> passenger and freight trains enabling to run at the regime (maximum) speeds and the maximum longitudinal gradients for them to start with acceleration of 0.25 m/s^2 when they stop on a gradient;
7. Comparing the gradients found in point 3 and point 6 above, and if it is needed, increasing the number of self-powered vehicles for passenger train and increasing the number of locomotives for freight train; determining again the number of passenger wagons and freight wagons with respect to the maximum weight of trains; calculating and comparing again the maximum gradients allowed for tractive conditions;
8. Calculating and checking the acceleration distances for <u>fully loaded</u> passenger and freight trains. The computations for acceleration will be performed in 3 speed intervals: one interval up to transition (critical) speed and two equal intervals between critical and regime speeds. (It is required that fully loaded passenger and freight trains starting their motion at point A be to reach their regime speed within the horizontal/level track-palye section. To make it, the number of self-powered vehicles and/or locomotives will be increased, if needed, and new (adjusted) acceleration distances will be computed. However, if a new train was made to maintain the requirement for the length of horizontal/level track-palye, the gradient calculation in point 6 will not be repeated; the gradients found in point 6 will be written on the control sheet.)

<u>2nd PART</u>

9. Calculating the total running times of passenger and freight trains (in A$\rightarrow$B direction). (There will be two equal speed intervals for braking before station B; a speed limit of 30 km/h is used in station B; this 30 km/h constant speed run in station is considered to be in the braking stage; full stop occurs at point B.)
10. Calculating the number of passenger and freight trains (services) for traffic demand. (The decimal train numbers calculated will be rounded up to the next integer number.)
11. Calculating the superelevation for curves with radius R_1 and R_2 based on the <u>even wearing requirement</u> and examining if these superelevations are appropriate for the passenger and freight trains.

<u>CONTROL CONDITIONS:</u>

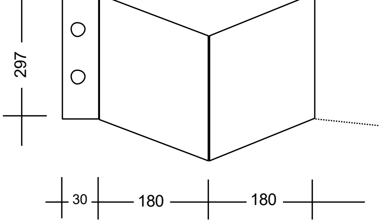
1. 1. This assignment has two parts as shown in the control sheet. At most two controls will be made for each part on the dates announced. At the end of the second control of each part, a score is given to that part.
2. 2. If there are incorrect results at the second control of the first part, the correct values will be written by the supervisor to the column “Given Result” on the control sheet.
3. Calculations and drawings in the assignment file must be prepared **<u>by hand</u>** (tables of running times may be given as computer printout as long as their calculation details are shown). The repeated computations can be shown clearly in detail only once, the results of the other computations can be directly shown on the associated tables.

<u>DRAWINGS GIVEN IN THE ASSIGNMENT FILE WITH RESPECT TO THE PARTS</u>

NOTE: You may use graph papers or plain papers for drawings prepared **<u>by hand</u>**.

D1. Drawing the new plan and showing the required data on it (**scale:** 1/100,000). **Plan must be in the file when handing in at the end of the 2nd part control.**

D2. Drawing the new profile and showing the required data on it (**horizontal scale:** 1/100,000; **vertical scale:** 1/10,000). **Profile must be in the file when handing at the end of the 2nd part control.**



For paper sheets (tables and drawings) larger than A4 size, please fold them into A4 size as shown next on the left, and then punch and attach them to the file.

D3. Drawing the running (speed-distance) graphics showing the stages of train movement. The horizontal axis is drawn parallel to the longer side of A4 paper (**horizontal scale:** free to choose; because the constant speed stage is too long, it may be drawn as dashed line; **vertical scale:** 1 cm = 30 km/h). **Drawings must be in the file when handing in at the end of the 2nd part control.**

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INS3442 Railway Engineering (2023-2024): Assignment-1 Review Sheet (Railways)

STUDENT NO:. . . . .
NAME :. . . . .
SURNAME :. . . . .
GROUP :. . . . .

ASSIGNMENT NUMBER
(For example, for Assign. No=1234; **d**=1, **c**=2, **b**=3, **a**=4)

d	c	b	a

1st PART

DO NOT USE THIS SHEET! ELECTRONIC FORM WILL BE USED FOR SUBMITTING YOUR CALCULATION RESULTS.

	1st Review	2nd Review	Given Result
1st external angle (Δ_1)			
2nd external angle (Δ_2)			
1st curve radius (R_1) (m)			
2nd curve radius (R_2) (m)			
Total alignment length (L_{AB}) (m)			
Average gradient (s_o) (‰) (Between points A and B)			
Applied gradient (s_u) (‰)			
PC_1 – Grade level (m)			
PT_1 - Grade level (m)			
PC_2 - Grade level (m)			
PT_2 - Grade level (m)			

File Ordination			
1st Part / 1st Control	☐ GOOD	☐ AVER.	☐ BAD
1st Part / 2nd Control	☐ GOOD	☐ AVER.	☐ BAD

	PASSENGER			FREIGHT		
	1st Review	2nd Review	Given Result	1st Review	2nd Review	Given Result
Number of self-pow. vehicles/locomotives						
Number of wagons						
s_{max} (regime) (‰)						
s_{max} (start) (‰)						
Total acceleration time (s)						
Total acceleration dist. (m)						
2nd PART						
Total braking time (s) (Including 30 km/h constant speed run at station B)						
Total braking distance (m) (Including 30 km/h constant speed run at station B)						
Regime distance (m)						
Regime time (s)						
Total running time (s)						
Number of trains (train/day-direction)						

d_1 (superelevation for R_1) (mm)			
d_2 (superelevation for R_2) (mm)			

File Ordination			
2nd Part / 1st Control	☐ GOOD	☐ AVER.	☐ BAD
2nd Part / 2nd Control	☐ GOOD	☐ AVER.	☐ BAD

NOTES:
1) All of the results at each part must be written on the Review Sheet. The unwritten results are assumed to be incorrect.
2) The results with okay sign ✓ next to it are "CORRECT" and the results with ~~strikethrough~~ are "INCORRECT".
3) Please DO NOT write the correct results approved at the 1st review again to the 2nd review column.