RAILWAYS

Design of track geometry2

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Clearance

Clearance – a contour of free space for train operation along the line. All the buildings and devices have to be located outside of this contour, except the devices designed for direct cooperation with the train like the catenary cable and the track brakes.

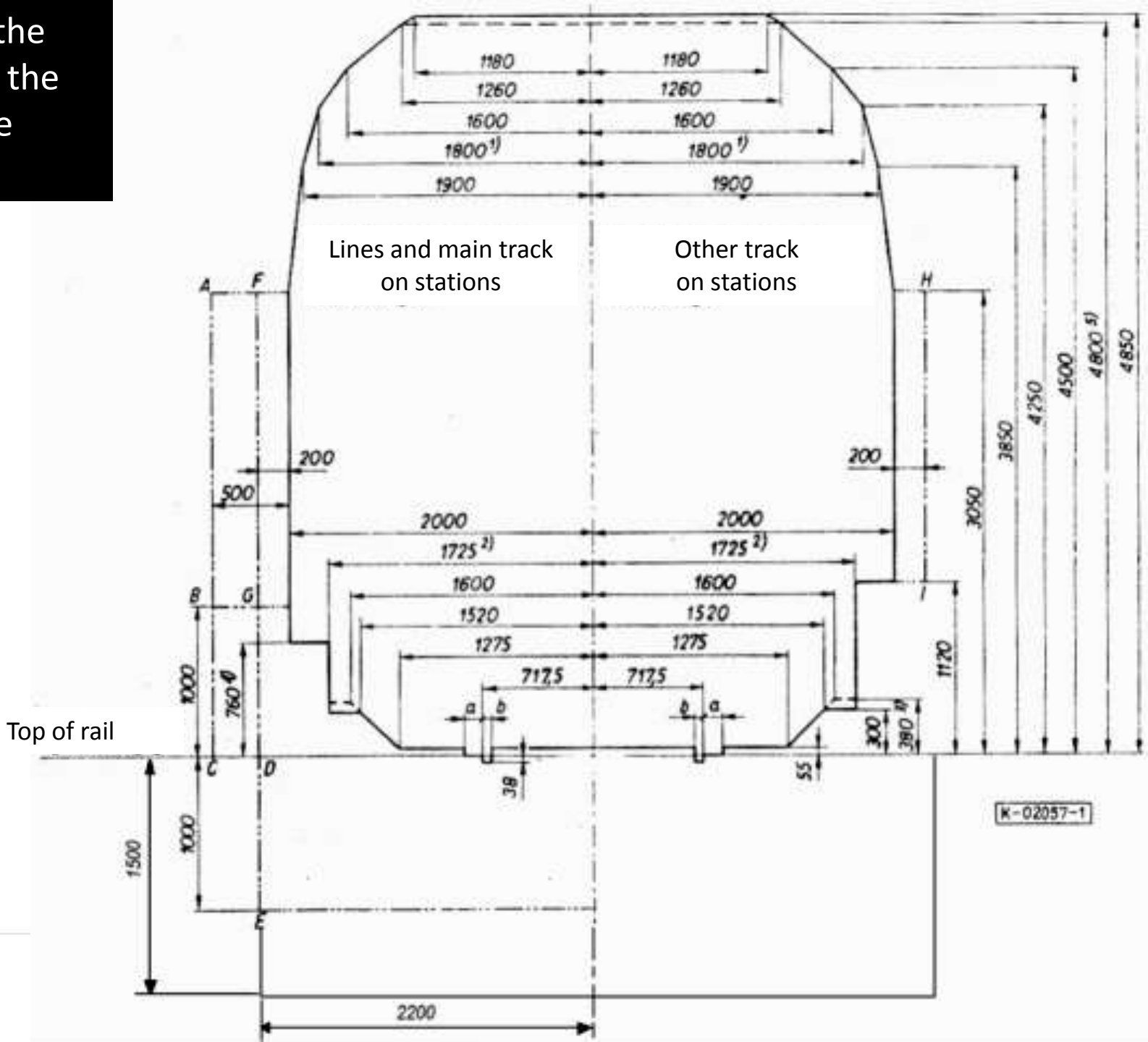
Remarks:

1. In horizontal direction the dimensions of the clearance (in [mm]) are measured from the axis of the track, and in vertical direction - from the head of the rail.
2. The nominal clearance dimensions apply to straight sections of track and to arc with the radius R>4000 m. In arc with R<4000 m the horizontal dimensions should be increased.

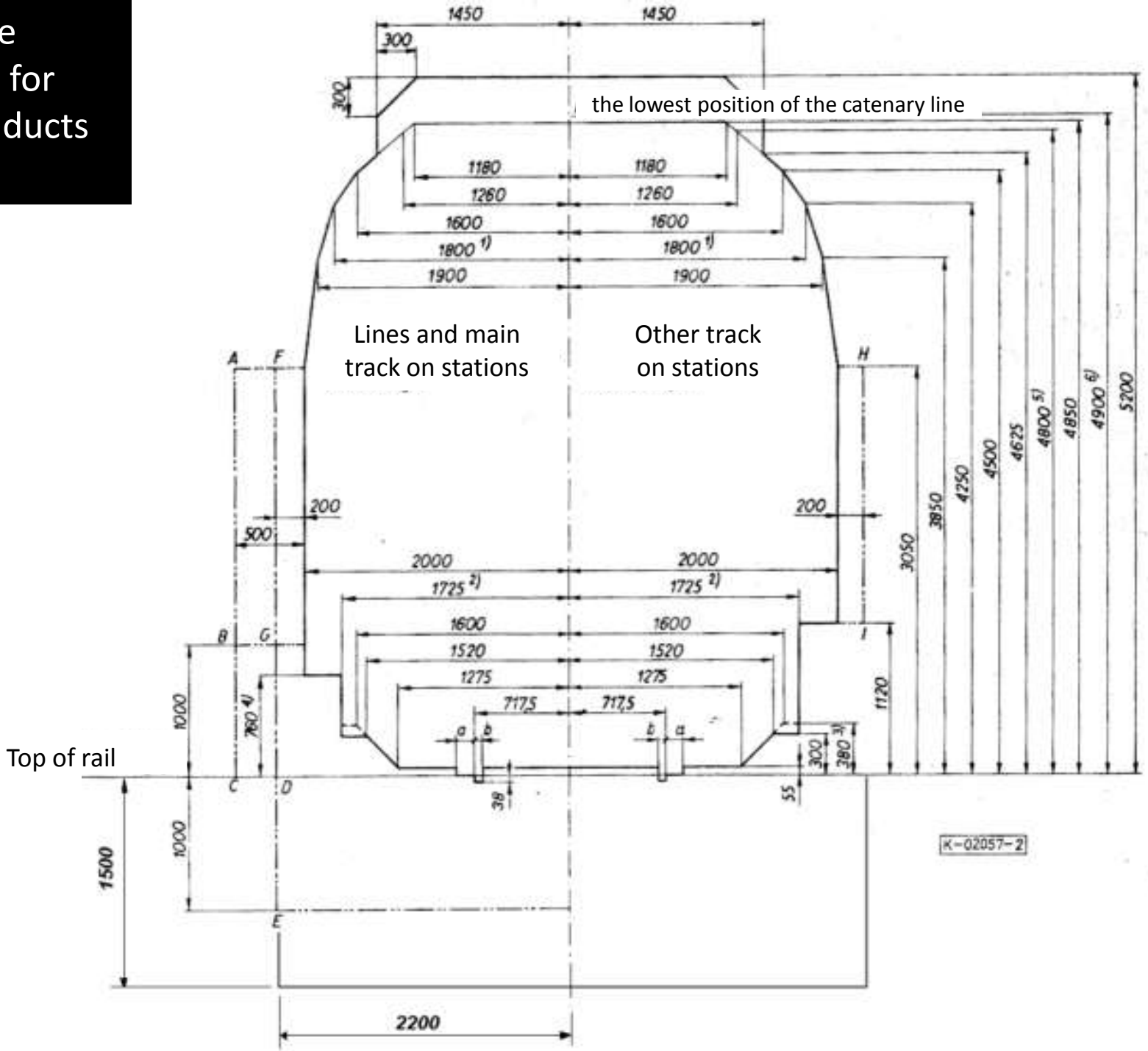




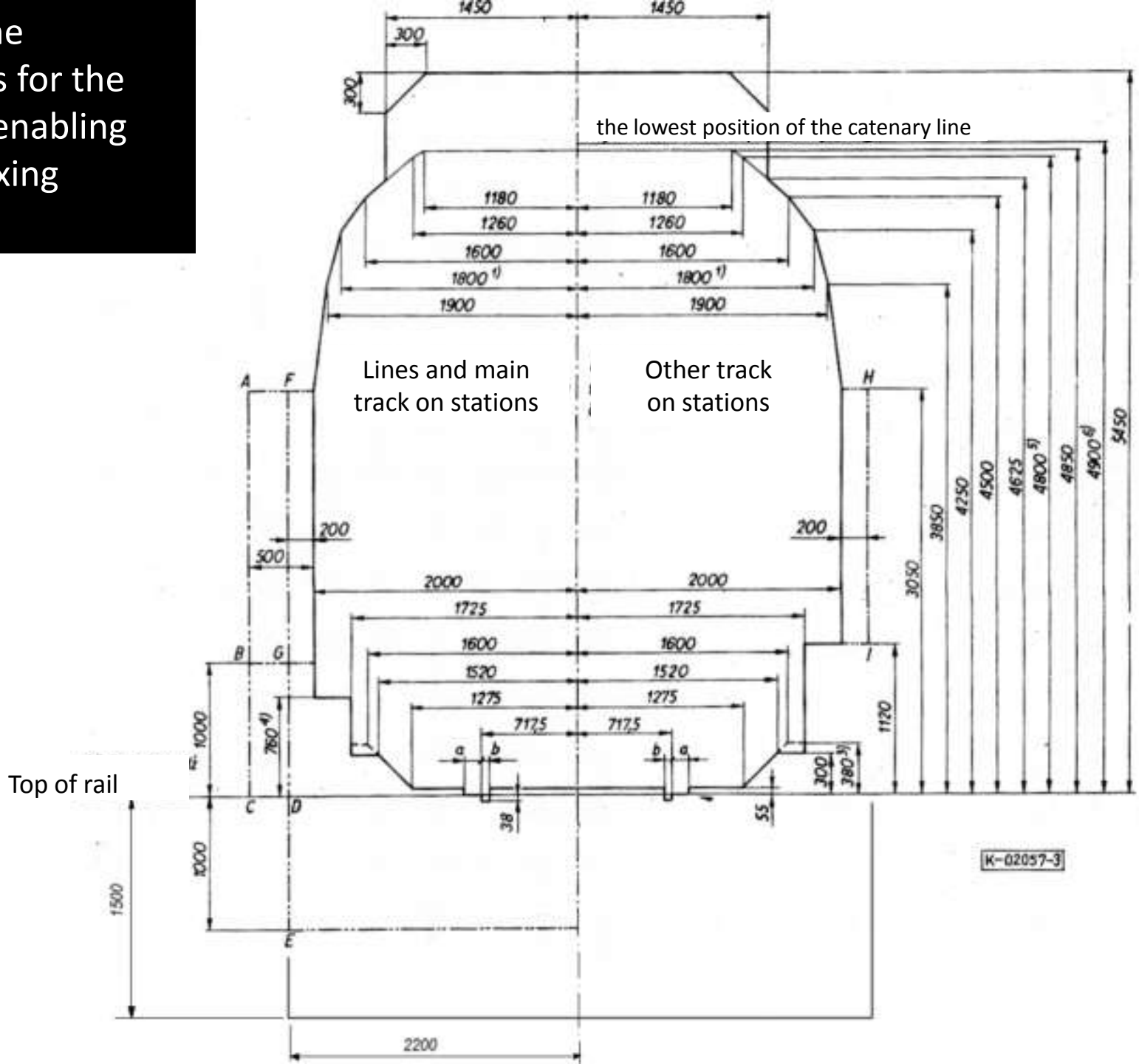
Clearance for the lines without the catenary cable (clearance A)



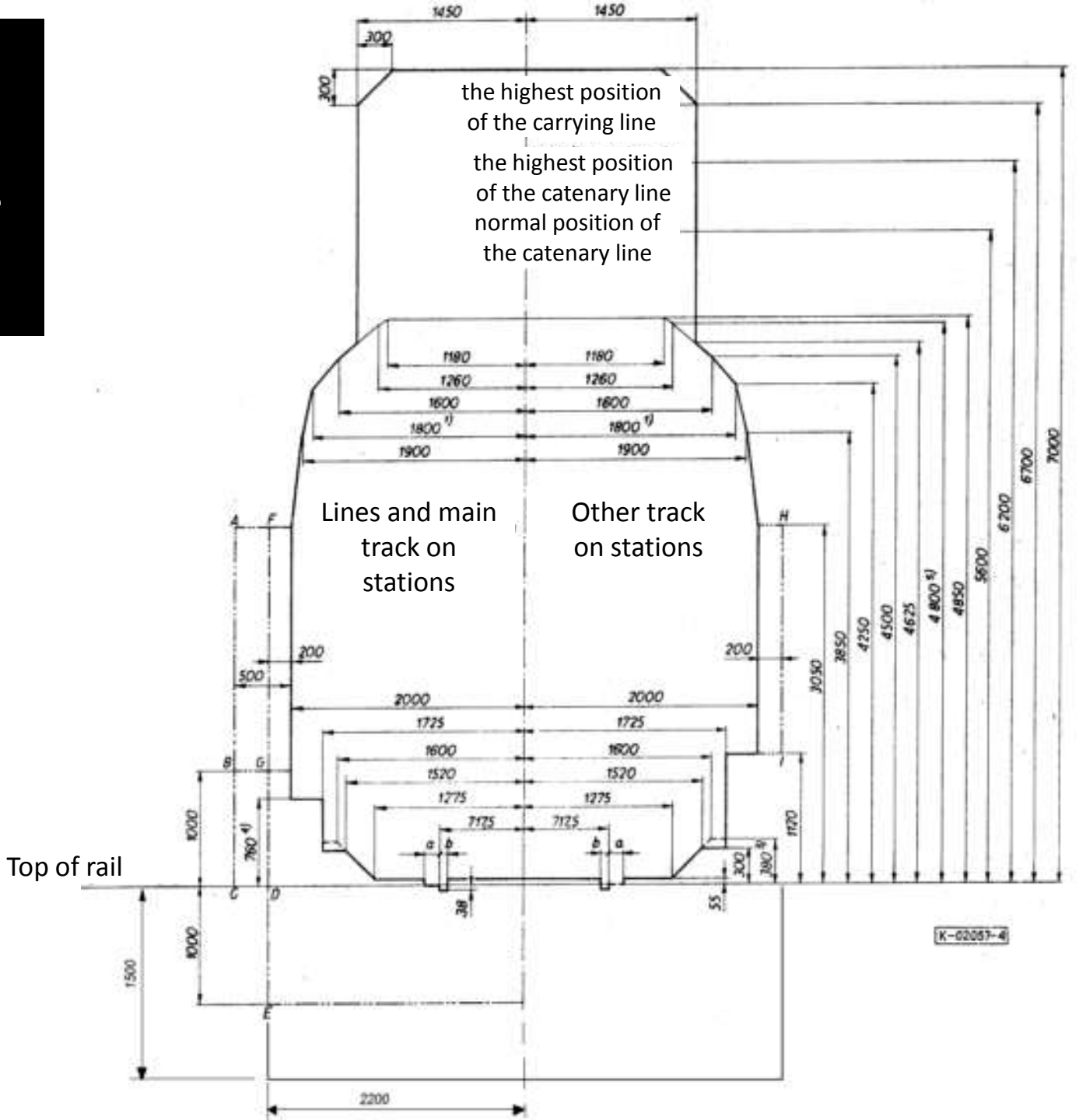
Clearance of the electrified lines for the existing viaducts (clearance B)



Clearance of the electrified lines for the new viaducts enabling the catenary fixing (clearance C)



Clearance of the electrified lines for the new viaducts and footbridges too flexible for the catenary fixing (clearance D)



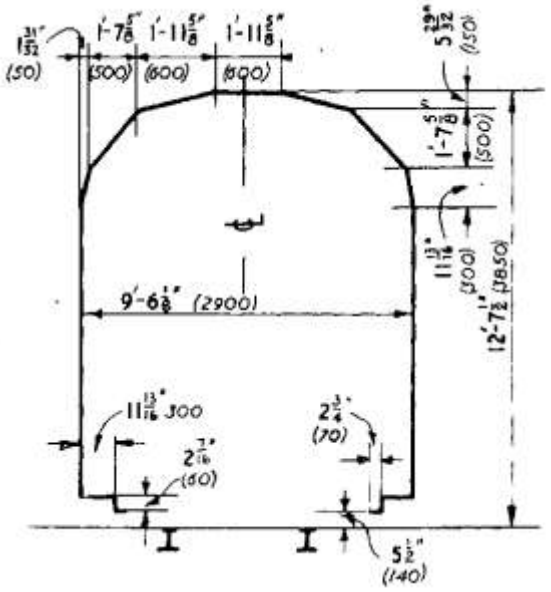
LEGEND:
AB – on passenger stops,
ABC – on bridges longer than 20 m with the structure under the track,
ABCDE – on lines, except platforms at the passenger stops and under viaducts,
ABGDE – on lines under new structures,
FG – on stations, for the main tracks and on bridges shorter than 20 m or longer than 20 m but with the track running though the structure,
FGD – on bridges shorter than 20 m or longer than 20 m with the structure under the track in case of side obstacles or on lines under the existing structures,
HI – on stations for the other tracks.



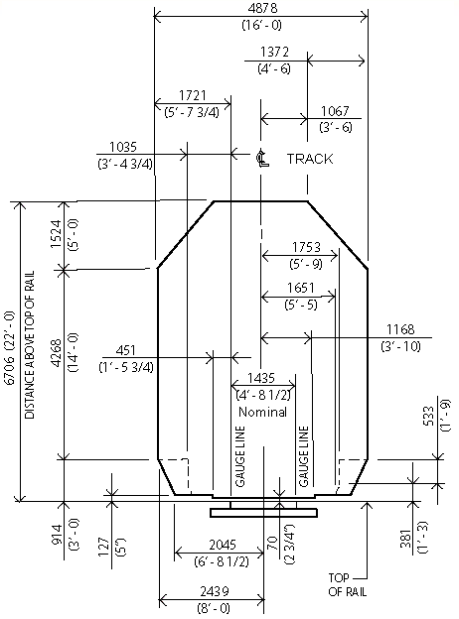
structure under the track



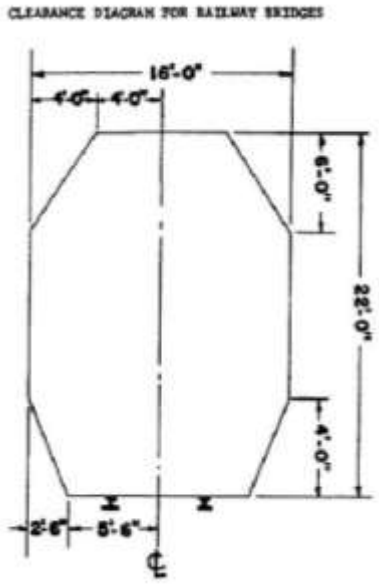
the track running through the structure

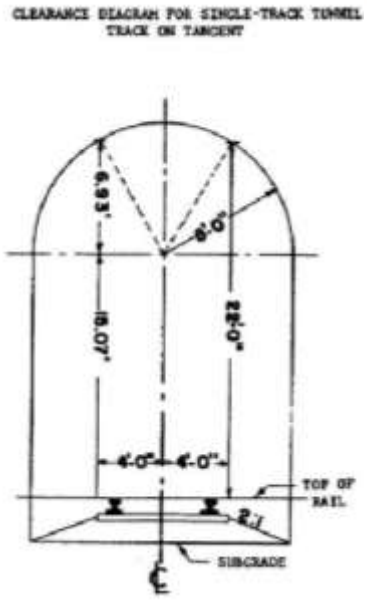


Eritrean Railways



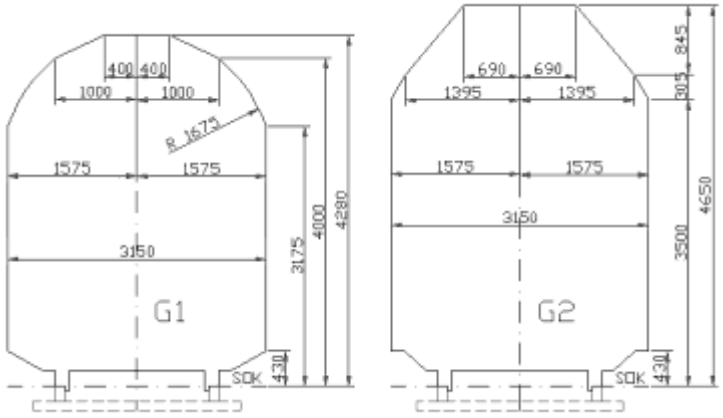
Canadian Railways



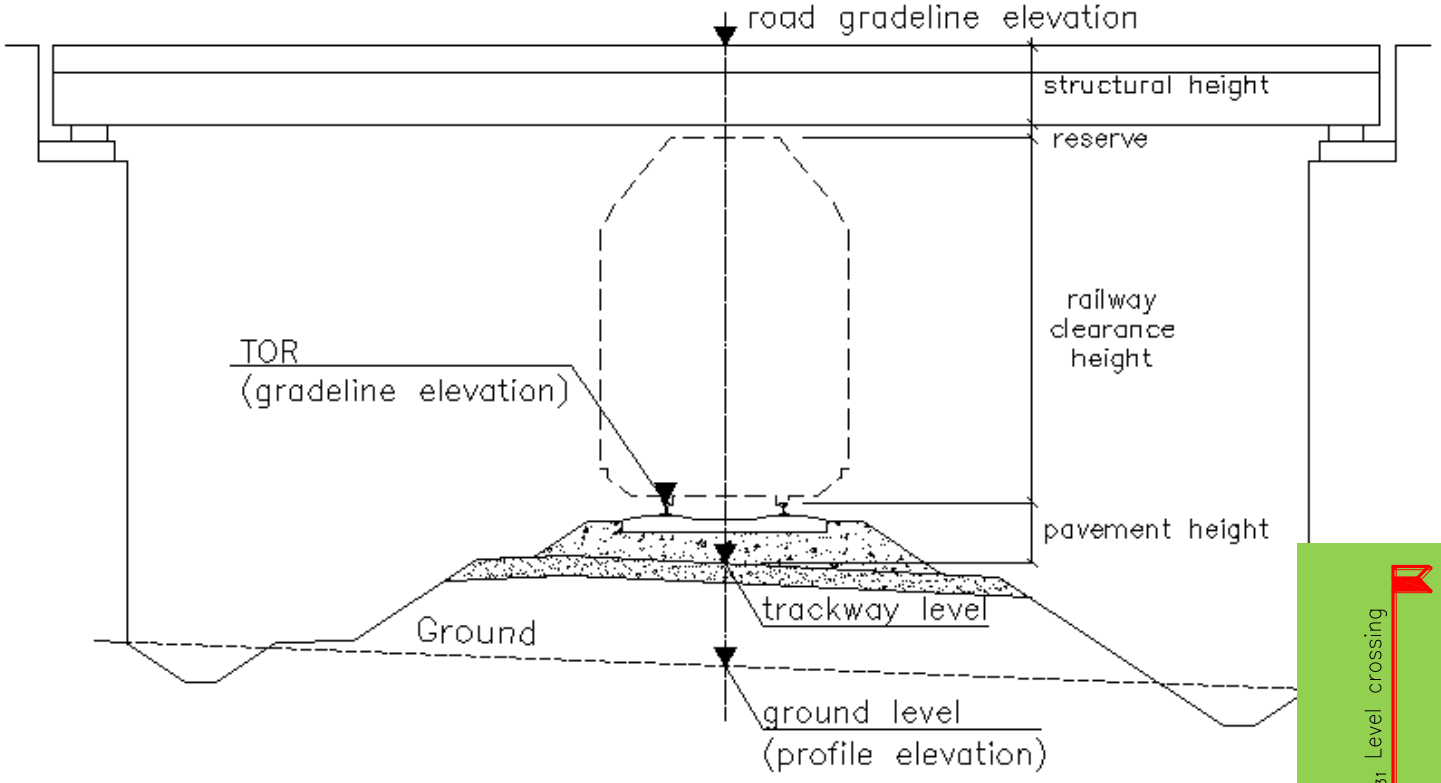


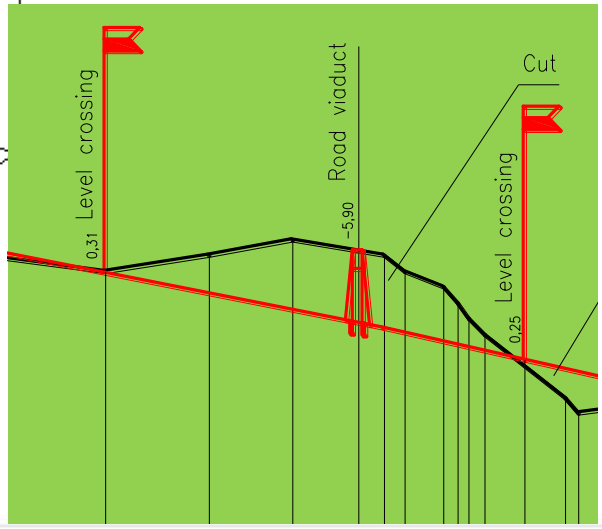
UK army

G1 - international and G2 – German Railways

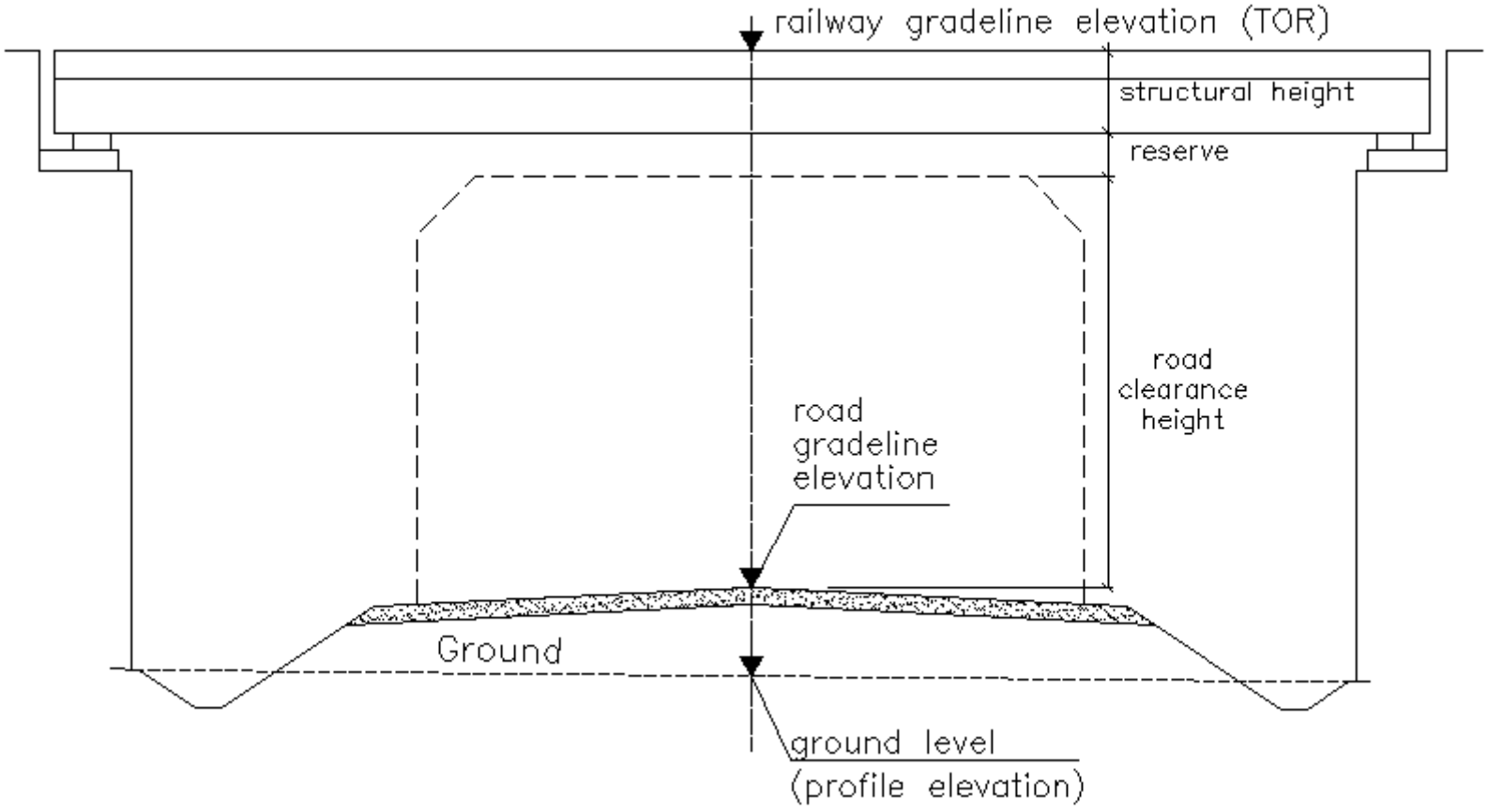


Clearance for design of a road viaduct





Clearance for design of a railway viaduct



Clearance on curves

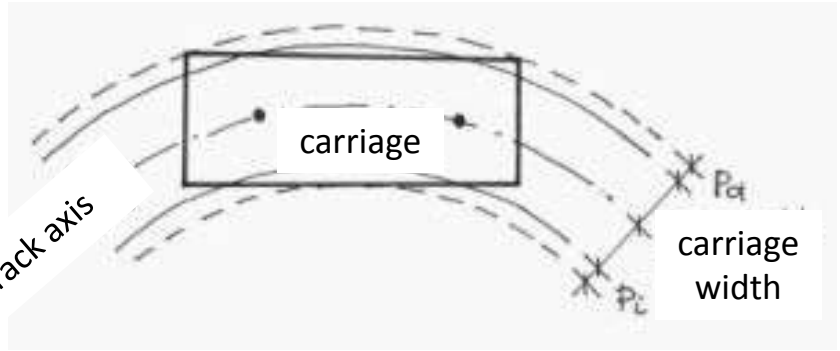
In arc with radius R<4000 m the body of carriage goes parallel to the chord made by the pins of wheelsets rotation and it tilts towards the centre of the arc, according to the cant. The clearance there must be widened:

- from the inner side of the arc:

$$\Delta b_w = \Delta b_R + \Delta b_h$$

- from the outer side of the arc:

$$\Delta b_z = \Delta b_R$$



where:

Δb_R - widening required for running along the chord,

Δb_h - widening required for tilting the carriage body due to the cant.

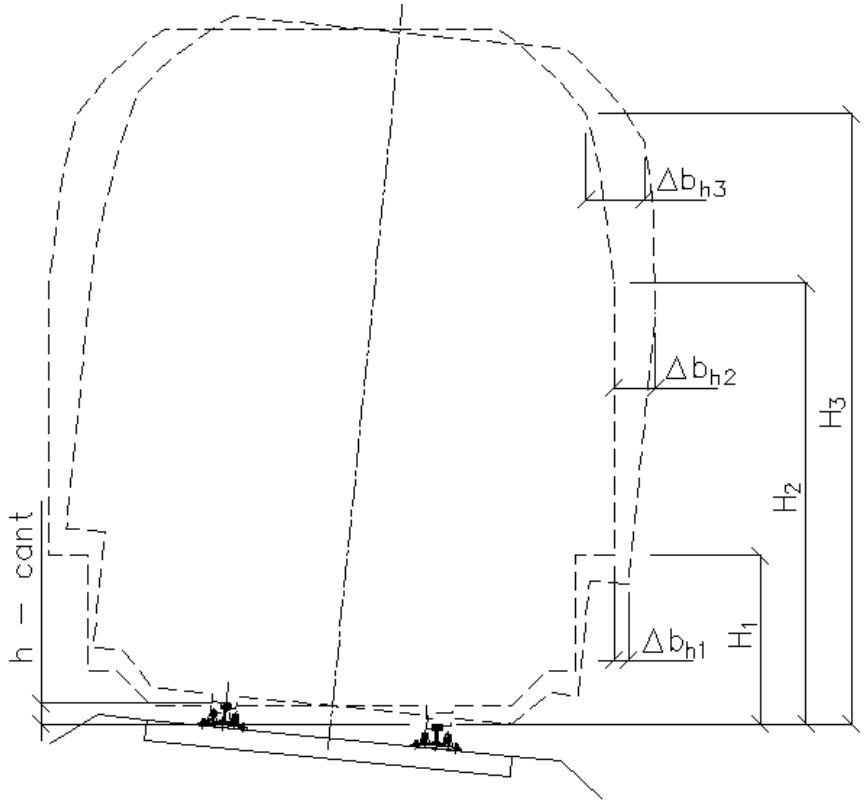
$$\Delta b_h = \frac{H_i h}{\sqrt{1500^2 - h^2}}$$

H_i - height of the clearance for a tangent section [mm],

h - the maximum cant [mm].

Clearance on curves

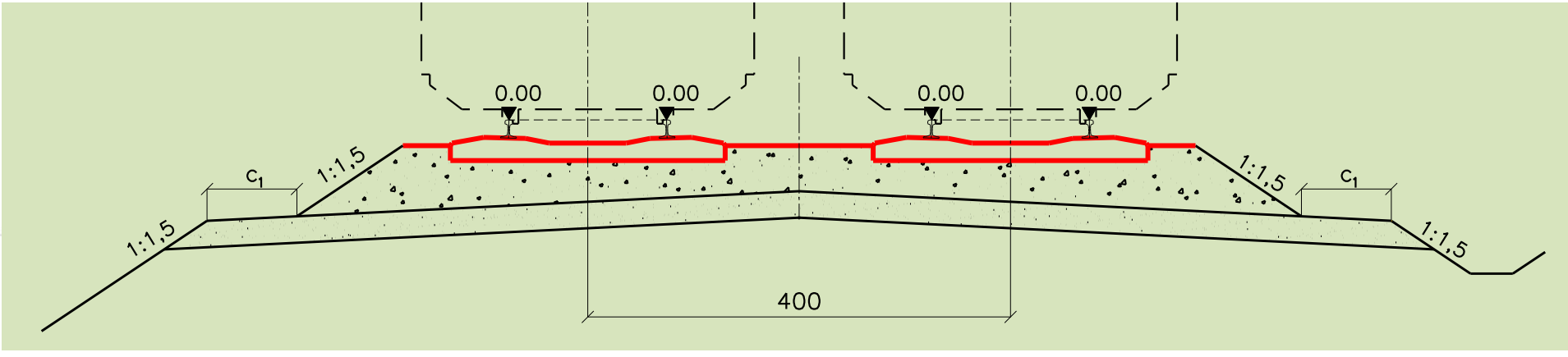




$$\Delta b_h = \frac{H_i h}{\sqrt{1500^2 - h^2}}$$

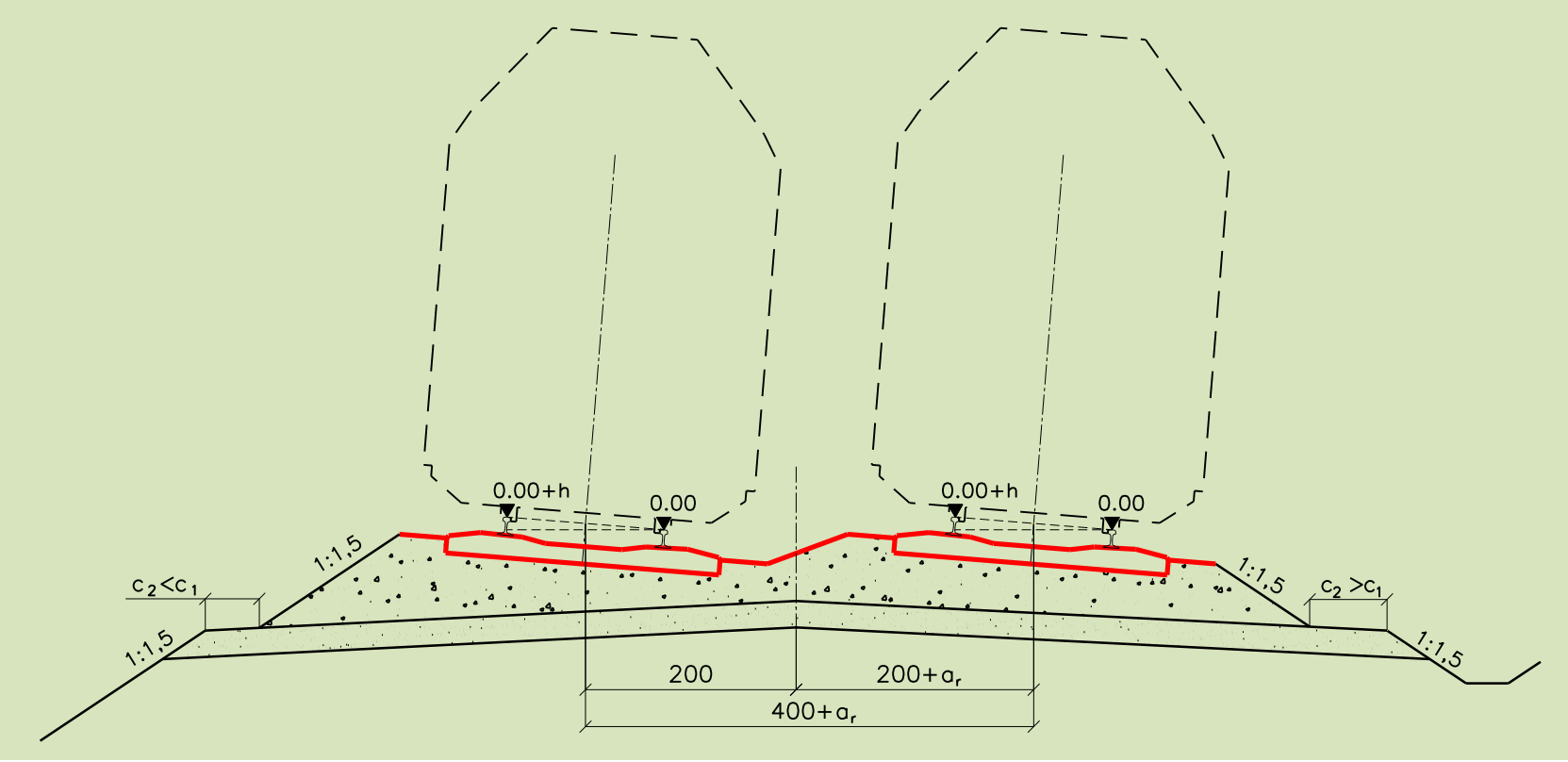
Space between tracks

Space between the tracks [m]	For train speed less than 160 km/h	For train speed higher than 160 km/h
Between tracks of modernized lines	4.00	4.50
Between tracks of new lines	4.20	4.50
Between tracks of new lines where signalling poles, lamps or power supply poles are planned	4.75	5.60
Between tracks of new lines where catenary supports are planned	4.90	5.80



Space between tracks on curves

1. Due to tilting the clearances of both tracks the space should be increased.
2. The widening can be applied by moving the inner track towards the arc centre.



The table taken from the Polish standard: „Dz.U. 151”

Radius [m]	In case of different cant in the 2 tracks				In other (most) cases [m]	
	On stations		On lines			
	when the speed is [km/h]					
	to 120	over 120	to 120	over 120	to 120	over 120
1	2	3	4	5	6	7
4 000	45	90	30	50	20	20
3 500	45	100	35	60	20	20
3 000	60	110	40	70	25	25
2 000	90	170	65	100	35	35
1 800	100	190	70	120	40	40
1 500	115	230	80	140	50	50
1 200	160	260	110	160	60	60
1 000	220	270	145	170	75	75
800	230	280	160	190	90	90
700	255	300	180	200	105	105
600	260	320	190	220	120	120
500	290	340	220	250	145	145
400	340	380	260	280	180	180
350	375	400	290	310	205	205
300	425	440	335	340	240	240
250	480	490	385	390	290	290
200	560	580	460	470	360	360
180	580	600	490	500	400	400

Rail-wheel cooperation

During the passage of a curved section of the track the wheels in one wheelset move on different radii of rails, thus blocking of wheels and skidding could occur. It results in damaging the rails and flattening of the wheels.

For making the passage easier the following facilities are applied:

- spring suspension of wheelsets in the frame of boogie enabling turning the wheels,
- the turnable boogies supporting the carriage body,
- a loose between the wheel flanges and the inner edges of rail heads (around 7 mm),
- the cant,
- widening of the gauge,
- conical running surfaces of wheels (1:20) and the same transversal tilt of the rails (1:40) - function of a differential mechanism.

Rail & wheel damages





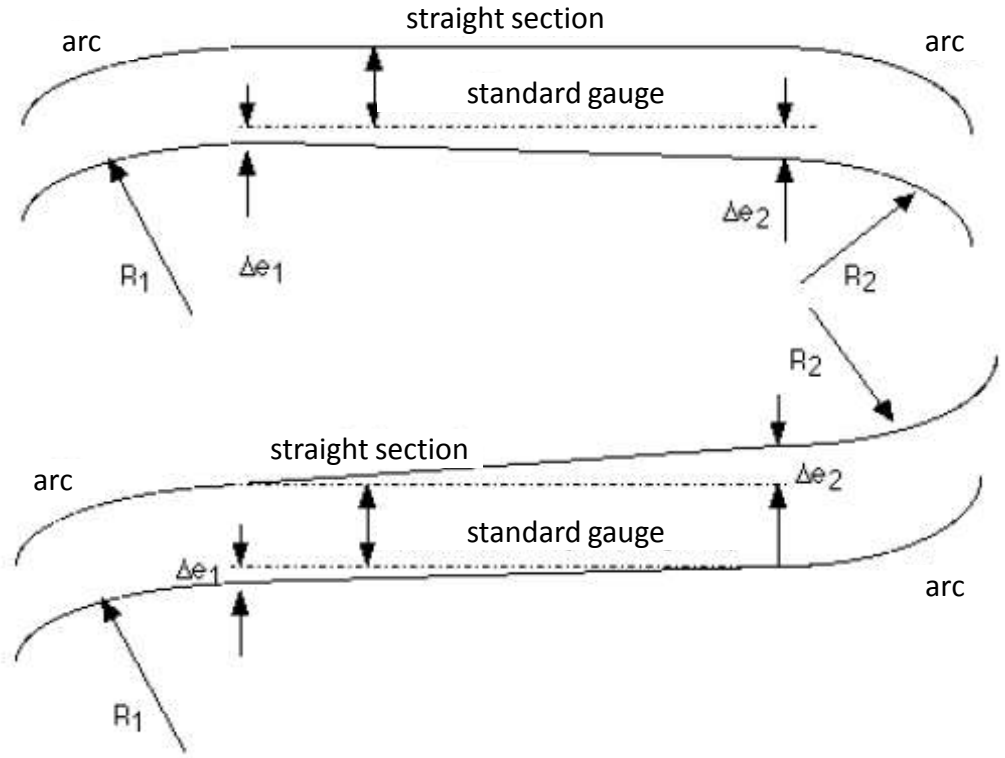




Widening in curves

On the straight sections and on curves with R>250 m the gauge is 1435 mm. On the curves with R<250 m the gauge should be widened (according to the table), moving the inner rail towards the centre of circle. The gradual application of the widening should be done on the length of transitional curve.

Radius [m]	Widening [mm]
R ≥ 250	0
200 ≤ R < 250	10
180 ≤ R < 200	15
160 ≤ R < 180	20
R < 160	25

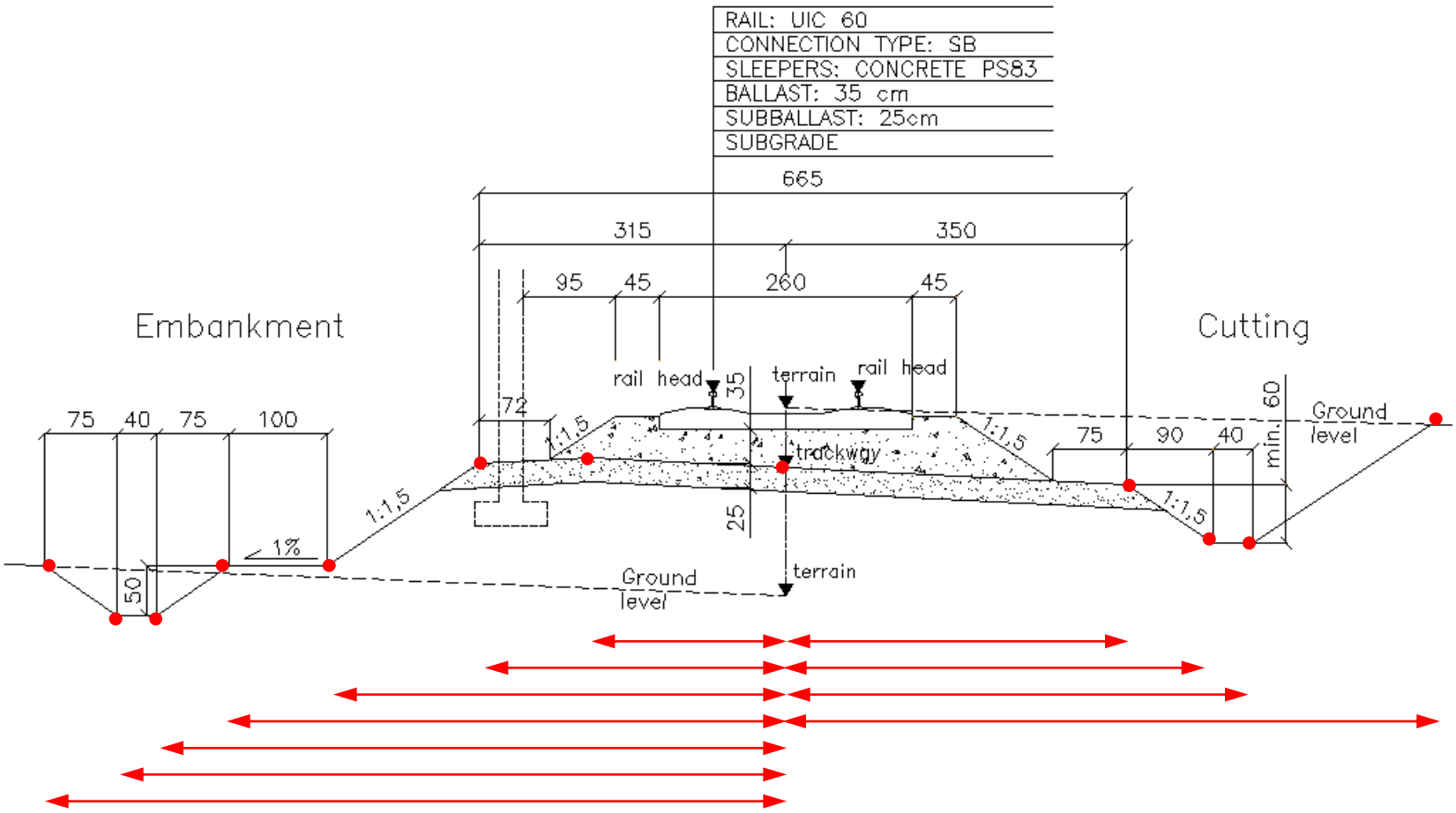


Guard rail

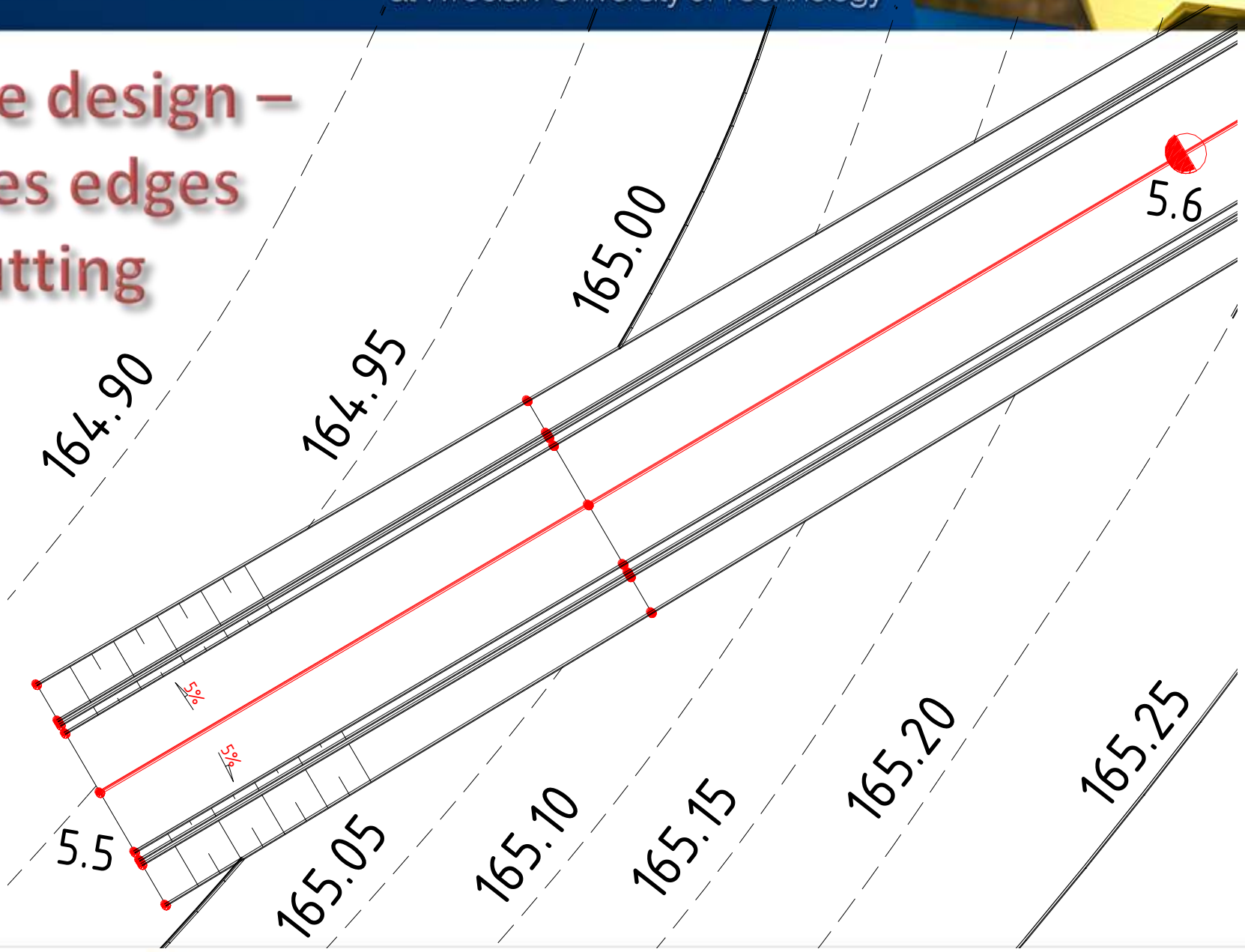
In curves with R<300 m at the inner rail , along the circular part as well as along the transition curves a guard rail (check rail) should be provided. It can be made of a used rail or of another rolled shape. The distance between the guard rail and the running rail should be 60 mm.



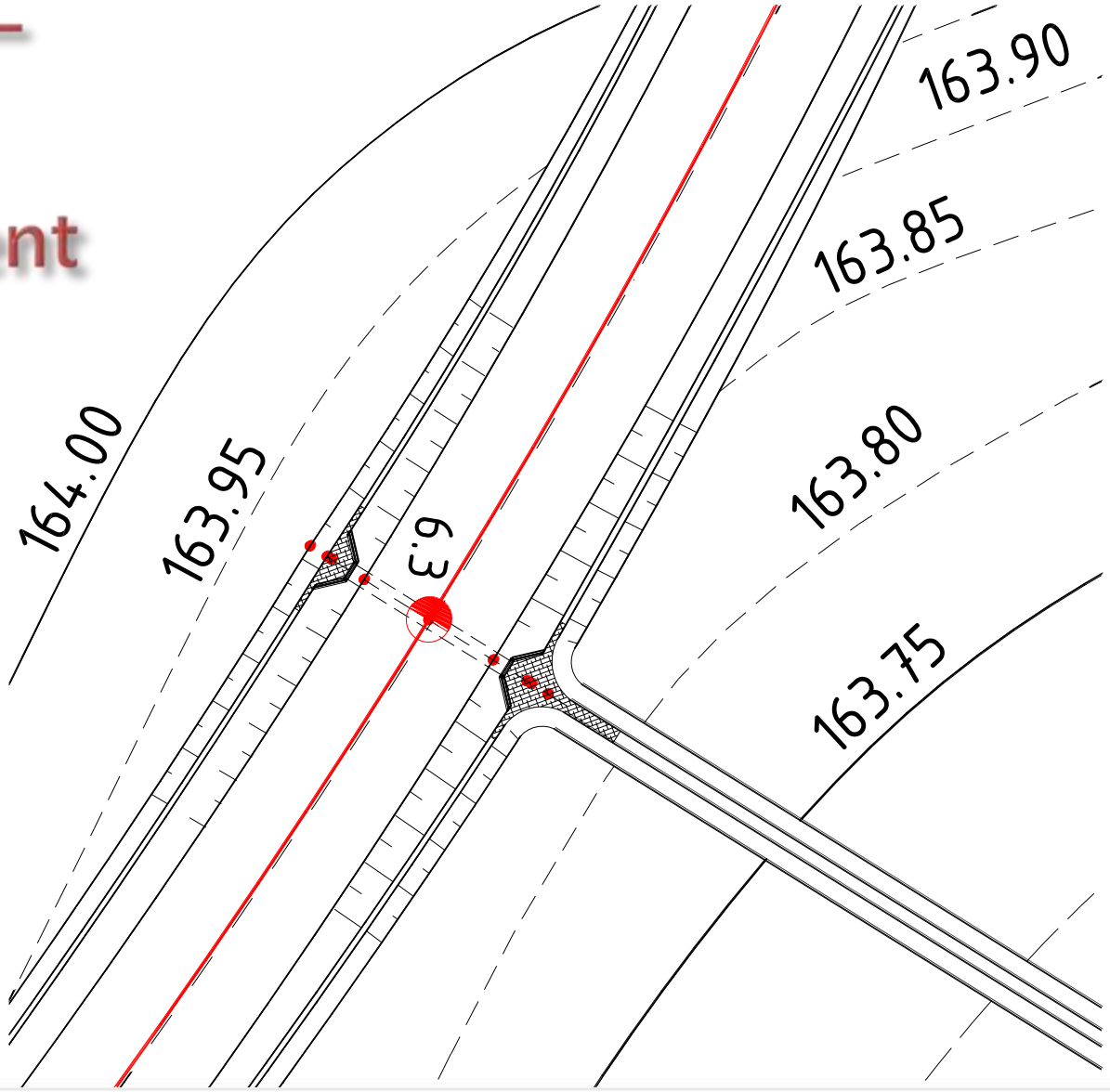
Standard cross section design



Plane design – slopes edges at cutting



Plane design – slopes edges at embankment and a culvert

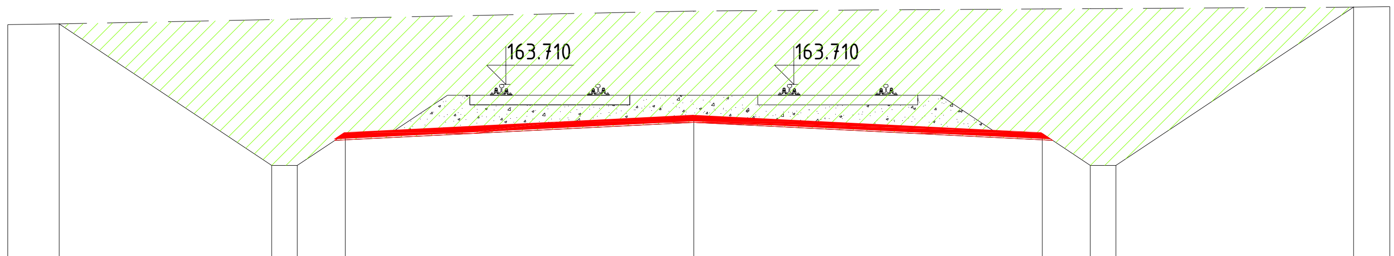


Characteristic cross section

km 5+500,00

CUTTING=33,71 m^2

EMBANKMENT=1,11 m^2



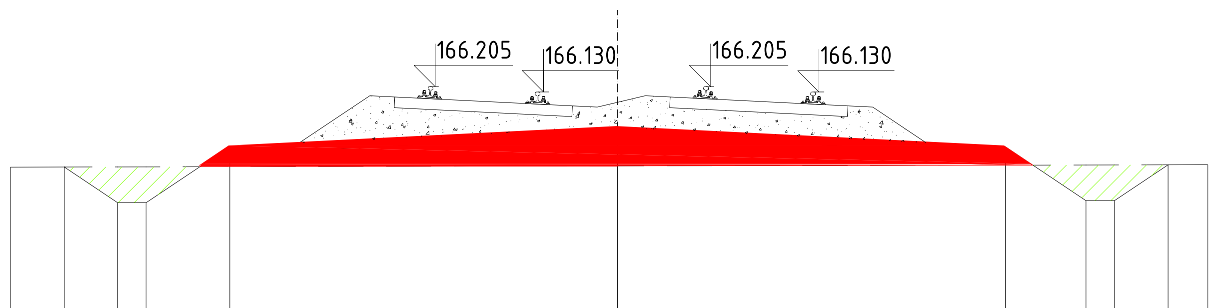
relative altitude 161,00 m a.s.l.

EXISTING TERRAIN	164,66	164,72	164,73	164,75	164,85	164,89	164,89	164,90	164,92
DESIGNED LEVEL	164,66	162,44	162,44	162,94	163,22	162,94	162,44	162,44	164,92
DISTANCE	9,92	6,60	6,20	5,45	0,00	5,45	6,20	6,60	10,31

km 6+020,51

CUTTING=1,15 m^2

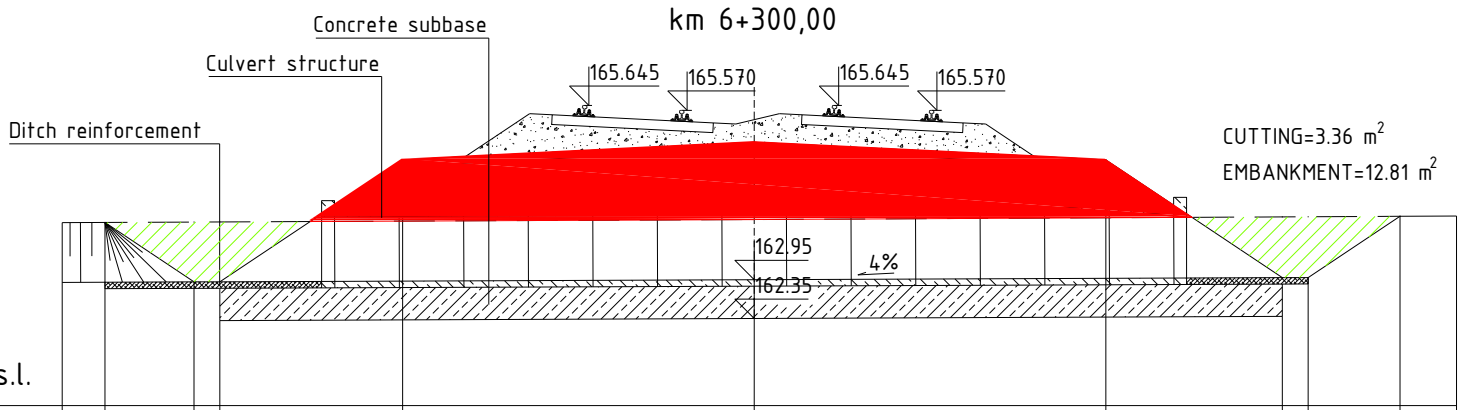
EMBANKMENT=4,52 m^2



relative altitude 163,00 m a.s.l.

EXISTING TERRAIN	165,07	165,08	165,08	165,08	165,09	165,10	165,10	165,10	165,11
DESIGNED LEVEL	165,07	164,57	164,57	165,36	165,64	165,36	164,60	164,60	165,11
DISTANCE	7,77	7,02	6,62	5,45	0,00	5,45	6,58	6,98	7,73

Characteristic cross section at a culvert



relative altitude 161.00 m a.s.l.

EXISTING TERRAIN	163,83	163,84	163,84	163,86	163,88	163,91	163,92	163,92	163,93	
DESIGNED LEVEL	162,91	162,91	162,91	164,80	165,08	164,80	162,98	162,98	163,93	
DISTANCE	10,06	8,68	8,28	5,45	0,00	5,45	8,18	8,58	10,00	