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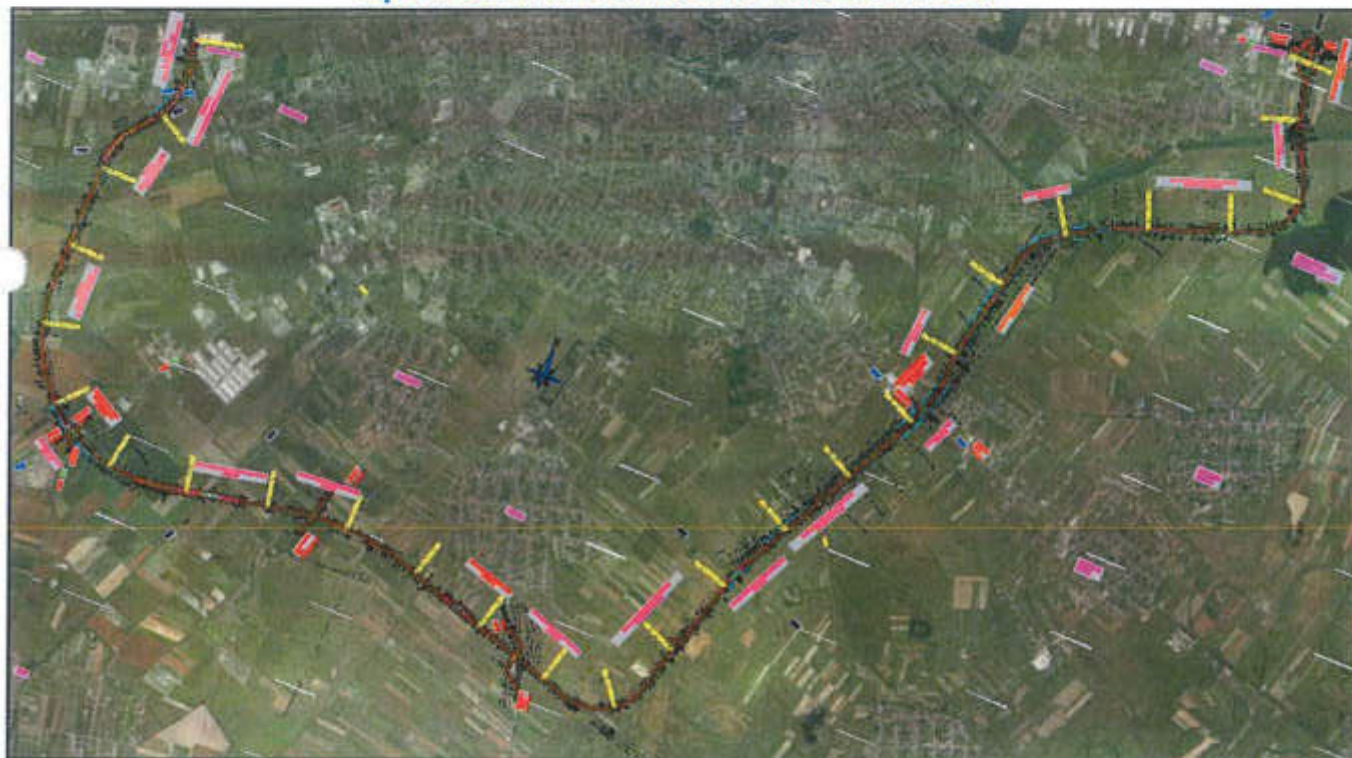
GUVERNUL ROMÂNIEI



Instrumente Structurale
2014-2020

POIM

**“Proiect co-finanțat din Fondul European de Dezvoltare Regională prin Programul
Operational Infrastructura Mare 2014-2020”**



BREVIARE DE CALCUL – PARTEA I – LUCRARI DE DRUM

Titlul contractului: Proiectare si Executie "Varianta de Ocolire Timisoara Sud"
Elaborare Proiect Tehnic Rest de Executat
Contract Nr. 550/36/09.02.2023
Proiect Nr. 556

Beneficiar: COMPANIA NATIONALA DE ADMINISTRARE
A INFRASTRUCTURII RUTIERE S.A.



Proiectant General: S.C. DP CONSULT S.A.



PT+DE
Piese scrise

DIMENSIONARE SISTEM RUTIER

Varianta de Ocolire Timisoara Sud

**Determinarea traficului de calcul pentru dimensionarea structurii rutiere pe
Varianta Timisoara-Sud**

**Proгноza traficului pe sectoarele Variantei de ocolire Timisoara-Sud pe
baza datelor furnizate de beneficiar**

Tabel 1

Sectorul de drum	Anul	MZA pe grupe de vehicule			
		Autoturisme	Autocamioane 2 osii	Autocamioane 3-4 osii	Vehicule articulate
DJ591 - DN59	2020	6539	90	26	257
	2025	7067	98	27	269
	2030	7645	119	31	332
	2035	9158	143	37	407
	2040	10799	168	43	489
DN59 - DJ592	2020	2789	105	204	1048
	2025	2996	115	211	1099
	2030	3213	136	245	1356
	2035	3829	161	290	1665
	2040	4497	188	333	2005
DJ592 - DN6	2020	1671	263	293	1103
	2025	1802	286	248	1156
	2030	1945	342	287	1426
	2035	2325	408	339	1745
	2040	2738	477	390	2100



Proгноza traficului pe sectoarele Variantei de ocolire Timisoara-Sud plecand de la anul 2021 de dare in exploatare al Variantei de ocolire

Tabel 2

Sectorul de drum	Anul	MZA pe grupe de vehicule			
		Autoturisme	Autocamioane 2 osii	Autocamioane 3-4 osii	Vehicule articulate
DJ591 - DN59	2021	6641	92	26	259
	2026	7179	102	28	281
	2031	7926	123	32	346
	2036	9465	148	38	422
	2041	9807	172	44	507
DN59 - DJ592	2021	2829	107	205	1058
	2026	3038	119	217	1146
	2031	3328	141	253	1413
	2036	3954	166	298	1728
	2041	4095	194	342	2081
DJ592 - DN6	2021	1696	267	241	1113
	2026	1830	296	255	1206
	2031	2016	354	297	1485
	2036	2402	421	349	1811
	2041	2488	492	401	2179

Echivalarea traficului de vehicule fizice in osii standard de 115 kN se face cu ajutorul coeficientilor de echivalare stabiliti pe tipuri de lucrari si grupe de vehicule.

Coeficientii de echivalare in osii standard de 115 kN sunt prezentati in normativul AND 584 – 2012 " Normativ pentru determinarea traficului de calcul pentru proiectarea drumurilor din punct de vedere al capacitatii portante si al capacitatii de circulatie ".

Coeficientii de echivalare a vehiculelor fizice in osii standard de 115 kN sunt determinati pe 3 tipuri de lucrari (tabelul 3):

- Sisteme rutiere suple si semirigide noi
- Ranforsare sisteme rutiere suple si semirigide
- Sisteme rigide.



Coeficientii de echivalare a vehiculelor fizice in osii de 115 kN

Tabel 3

Tipuri de structuri rutiere	Grupe de vehicule					
	Autocamioane si derivate cu 2 osii	Autocamioane si derivate cu 3-4 osii	Autovehicule articulate	Autobuze	Tractoare cu remorci	Tren rutier
Suple si semirigide	0.1	0.7	0.9	0.6	0.1	1
Ranforsari structuri rutiere suple si semirigide	0.1	0.8	1.1	0.6	0.1	1.2
Rigide	0.2	2.6	1.5	0.6	0.1	1.4

Traficul MZA in osii standard de 115 kN pe sectoarele Varianta de ocolire determinat prin echivalarea in osii standard a traficului de vehicule fizice prognozate pentru perioada 2025 – 2040 (tabelul 1) precum si traficul de calcul (N_c) si clasa de trafic sunt prezentate in tabelul 4.

Tabel 4

Structura rutiera	Sectorul de drum VOTM	Trafic MZA, osii standard 115 kN, in anul				Trafic de calcul N_{c15} M.O.S.
		2021	2026	2031	2036	
Supla si semirigida	DJ591 - DN59	261	283	346	421	0.89
	DN59 - DJ592	1106	1195	1463	1780	3.74
	DJ592 - DN6	1197	1294	1580	1916	4.04
Rigida	DJ591 - DN59	470	515	627	761	4.17*
	DN59 - DJ592	2141	2307	2806	3400	18.62*
	DJ592 - DN6	2350	2531	3071	3708	20.30*

* N_{c30}

Pentru proiectarea structurii rutiere pe Varianta de ocolire se recomanda sa se adopte traficul de calcul cel mai mare, respectiv de **4.04 m.o.s.**

Nc := 4.04 m.o.s. perioada de perspectiva 15 ani 2021 - 2036

VARIANTA DE OCOLIRE, BUCLE SI BRETELE

1. Dimensionarea straturilor in alcatuirea sistemului rutier nou

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (M PD 177-2001

1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura MAS16
- 6 cm strat de legatura BAD20
- 14 cm strat de baza AB 31.5
- 30 cm strat superior de fundatie din platra sparta amestec optimal
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

P5 - (tip pamant, teren de fundare)

Modul de elasticitate
dinamic

$E_t :=$

3600·MPa
3000·MPa
5000·MPa
500·MPa
234.41·MPa
90·MPa
70·MPa

Grosime

$h_t :=$

4·cm
6·cm
14·cm
30·cm
30·cm
15·cm
∞ ·m
2

Coefficientul
lui Poisson

$\mu_t :=$

0.35
0.35
0.35
0.27
0.27
0.27
0.42

1.2. Caracteristicile zonei

- tipul climateric
- regimul hidrologic

I

2b corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P5 (predominant) . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 70 MPa pentru tipul de pamant P5.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolanici

Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 90 MPa conform Fig. 2 pag. 52/PD 177, pentru grosimea de 15 cm strat de forma din balast.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modulului de elasticitate dinamic E_{balast} este in functie de cea a materialelor din stratul suport (din materiale granulare) E_p si se calculeaza cu relatia (3)

$h_{balast} := 300 \text{ mm}$ grosimea stratului de forma din balast

$E_p := 90 \text{ MPa}$ modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$

$E_{balast} = 234.41 \text{ MPa}$

coeficientul lui Poisson are valoarea: 0,27

$N_c := 4.04$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice orizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica orizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 93.2 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 4.27 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 6.48 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.623$$

$$RDO_{adm1} := 0.85 \quad \text{pentru drumuri europene}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 130 \quad \text{microdeformatii}$$

$$\epsilon_{z1} \quad \text{deformatia specifica verticala de compresiune la nivelul pamantului de fundare}$$

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 329 \cdot N_c^{-0.27} \quad \text{microdeformatii}$$

$$\epsilon_{zadm1} \quad \text{deformatia specifica verticala admisibila la nivelul pamantului de fundare}$$

$$\epsilon_{zadm1} = 225.67 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

DRUM: VARIANTA DE OCOLIRE TIMISOARA SUD

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm
Stratul 1: Modulul 4200. MPa, Coeficientul Poisson .350, Grosimea 24.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 3: Modulul 234. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 4: Modulul 90. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 70. MPa, Coeficientul Poisson .420 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-24.00	.538E+00	.932E+02	-.118E+03
.0	24.00	.195E-01	.932E+02	-.261E+03
.0	.00	-.978E+00	-.993E+02	.142E+02
.0	-99.00	.358E-02	.556E+02	-.120E+03
.0	99.00	.297E-03	.556E+02	-.130E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



D

SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere

- 1.1. Se propune urmatorul sistem rutier
- 4 cm strat de uzura din MAS16
 - 6 cm strat de legatura din BAD20
 - 14 cm strat de baza mixtura asfaltica AB31.5
 - 30 cm strat superior de fundatie din piatra sparta amestec optimal
 - 30 cm strat inferior de fundatie din balast
 - 15 cm strat de forma din balast

$n := 6$

$i := 1..n$

$h_i :=$

$C_i :=$

4·cm
6·cm
14·cm
30·cm
30·cm
15·cm

0.50
0.60
0.50
0.70
0.70
0.70

P5 (tip pamant, teren de fundare)

Coeficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 99 \cdot \text{cm}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 65.1 \cdot \text{cm}$$

Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 33.9 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 - 90, in functie de indicele de inghet I, tipul climatic si conditiile hidrologice.

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P5

adancimea de inghet 60-70 cm

$I_{med}^{3/30}$ 429 Timisoara

curba 8 - rezulta 70 cm adancime de inghet

Adancimea de inghet in pamantul de fundatie

$$Z_f := 70 \text{cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 103.9 \cdot \text{cm}$$



Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}}$$

$$K = 0.627$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.50$$

pentru structuri rutiere suple

$$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$$



1. Dimensionarea straturilor in alcatuirea sistemului rutier nou - Varianta de Ocolire Timisoara Sud

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (Metoda analitica) indicativ PD 177-2001

	Modul de elasticitate dinamic	Grosime	Coefficientul lui Poisson
	$E_t :=$	$h_t :=$	$\mu_t :=$
1.1. Se propune urmatorul sistem rutier			
- 4 cm strat de uzura MAS16	3600·MPa	4·cm	0.35
- 6 cm strat de legatura BAD20	3000·MPa	6·cm	0.35
- 14 cm strat de baza AB 31.5	5000·MPa	14·cm	0.35
- 30 cm strat superior de fundatie din platra sparta amestec optimal	500·MPa	30·cm	0.27
- 30 cm strat inferior de fundatie din balast	234.41·MPa	30·cm	0.27
- 15 cm strat de forma din balast	90·MPa	15·cm	0.27
	70·MPa	$\frac{\infty}{2}$ ·m	0.35

P4 (tip pamant, teren de fundare)

1.2. Caracteristicile zonei

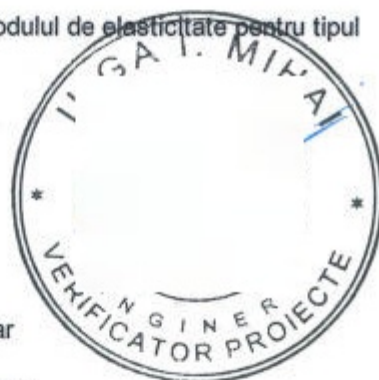
- tipul climateric I
- regimul hidrologic 2b

corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P4 . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 70 MPa pentru tipul de pamant P4.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolanici



Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 90 MPa conform Fig. 2 pag. 52/PD 177, pentru grosimea de 15 cm strat de forma din balast.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modulului de elasticitate dinamic E_{balast} este in functie de cea a materialelor din stratul suport (din materiale granulare) E_p si se calculeaza cu relatia (3)

$h_{balast} := 300 \text{ mm}$ grosimea stratului de forma din balast

$E_p := 90 \text{ MPa}$ modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$$

$$E_{balast} = 234.41 \text{ MPa}$$

coeficientul lui Poisson are valoarea: 0,27

$N_c := 4.04$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice orizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica orizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 95.5 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 4.27 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 5.89 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.686$$

$$RDO_{adm1} := 0.85 \quad \text{pentru drumuri europene}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 139 \quad \text{microdeformatii}$$

ϵ_{z1} deformatia specifica verticala de compresiune la nivelul pamantului de fundare

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 329 \cdot N_c^{-0.27} \quad \text{microdeformatii}$$

ϵ_{zadm1} deformatia specifica verticala admisibila la nivelul pamantului de fundare

$$\epsilon_{zadm1} = 225.67 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

VARIANTA DE OCOLIRE TIMISOARA SUD

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm

Stratul 1: Modulul 4200. MPa, Coeficientul Poisson .350, Grosimea 24.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .350, Grosimea 30.00 cm
Stratul 3: Modulul 234. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 4: Modulul 90. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 70. MPa, Coeficientul Poisson .350 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-24.00	.553E+00	.955E+02	-.120E+03
.0	24.00	.100E-01	.955E+02	-.250E+03
.0	.00	-.986E+00	-.101E+03	.155E+02
.0	-99.00	.333E-02	.541E+02	-.120E+03
.0	99.00	.965E-03	.541E+02	-.139E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere

$n := 6$

$i := 1 .. n$

1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura din MAS16
- 6 cm strat de legatura din BAD20
- 14 cm strat de baza mixtura asfaltica AB31.5
- 30 cm strat superior de fundatie din piatra sparta amestec optimal
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

$h_i :=$

$C_i :=$

4·cm	0.50
6·cm	0.60
14·cm	0.50
30·cm	0.70
30·cm	0.70
15·cm	0.70

P4 - (tip pamant, teren de fundare)

Coeficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i \quad H_{sr} = 99 \cdot \text{cm}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i) \quad H_e = 65.1 \cdot \text{cm}$$

Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e \quad \Delta Z = 33.9 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 - 90, in functie de indicele de inghet I, tipul climatic si conditiile hidrologice.

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P4

adancimea de inghet 60-70 cm

$I_{med}^{3/30}$ 429 Timisoara

curba 4 - rezulta 80 cm adancime de inghet



Adancimea de inghet in pamantul de fundatie

$$Z_f := 80\text{cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 113.9\text{-cm}$$

Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}}$$

$$K = 0.572$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.50$$

pentru structuri rutiere suple

$$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$$



1. Dimensionarea straturilor in alcatuirea sistemului rutier nou - Varianta de Ocolire Timisoara Sud

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (Metoda analitica)
indicativ PD 177-2001

Modul de elasticitate dinamic Grosime Coeficientul lui Poisson

1.1. Se propune urmatoarul sistem rutier

- 4 cm strat de uzura MAS16
- 6 cm strat de legatura BAD20
- 14 cm strat de baza AB 31.5
- 30 cm strat superior de fundatie din piatra sparta amestec optimal
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

$E_t :=$

$h_t :=$

$\mu_t :=$

3600·MPa	4·cm	0.35
3000·MPa	6·cm	0.35
5000·MPa	14·cm	0.35
500·MPa	30·cm	0.27
216.18·MPa	30·cm	0.27
83·MPa	15·cm	0.27
65·MPa	$\frac{\infty}{2}$ ·m	0.30

P3 (tip pamant, teren de fundare)

1.2. Caracteristicile zonei

- tipul climateric
- regimul hidrologic

I

2b corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P3 . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 65 MPa pentru tipul de pamant P3.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolanici



Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 83 MPa conform Fig. 2 pag. 52/PD 177 pentru grosimea de 15 cm strat de forma din balast.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modului de elasticitate dinamic E_{balast} este in functie de cea a materialelor din stratul suport (din materiale granulare) E_p si se calculeaza cu relatia (3)

$h_{balast} := 300$ mm grosimea stratului de forma din balast

$E_p := 83$ MPa modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$$

$E_{balast} = 216.18$ MPa

coeficientul lui Poisson are valoarea: 0,27

$N_c := 4.04$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice orizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica orizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 95.5 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 4.27 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 5.89 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.686$$

$$RDO_{adm1} := 0.85 \quad \text{pentru drumuri europene}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 147 \quad \text{microdeformatii}$$

ϵ_{z1} deformatia specifica verticala de compresiune la nivelul pamantului de fundare

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 329 \cdot N_c^{-0.27} \quad \text{microdeformatii}$$

ϵ_{zadm1} deformatia specifica verticala admisibila la nivelul pamantului de fundare

$$\epsilon_{zadm1} = 225.67 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

DRUM:

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm

Stratul 1: Modulul 4200. MPa, Coeficientul Poisson .350, Grosimea 24.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .350, Grosimea 30.00 cm
Stratul 3: Modulul 234. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 4: Modulul 83. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 65. MPa, Coeficientul Poisson .300 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-24.00	.554E+00	.955E+02	-.120E+03
.0	24.00	.102E-01	.955E+02	-.249E+03
.0	.00	-.989E+00	-.101E+03	.161E+02
.0	-99.00	.296E-02	.546E+02	-.125E+03
.0	99.00	.131E-02	.546E+02	-.147E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere

$n := 6$

$i := 1..n$

1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura din MAS16
 - 6 cm strat de legatura din BAD20
 - 14 cm strat de baza mixtura asfaltica AB31.5
 - 30 cm strat superior de fundatie din piatra sparta amestec optimal
 - 30 cm strat inferior de fundatie din balast
 - 15 cm strat de forma din balast
- P3 - (tip pamant, teren de fundare)

$h_i :=$

$C_i :=$

4·cm
6·cm
14·cm
30·cm
30·cm
15·cm

0.50
0.60
0.50
0.70
0.70
0.70

Coeficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 99 \cdot \text{cm}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 65.1 \cdot \text{cm}$$

Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 33.9 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 - 90, in functie de indicele de inghet I, tipul climatic si conditiile hidrologice.

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P3

adancimea de inghet 60-70 cm

$I_{med}^{3/30}$

429

Timisoara

curba 3 -

rezulta 70 cm adancime de inghet



Adancimea de inghet in pamantul de fundatie

$$Z_f := 85\text{cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 118.9\text{ cm}$$

Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}}$$

$$K = 0.548$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.50$$

pentru structuri rutiere suple

$$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$$



Drumul	Traficul MZA, osii standard 115 kN				Traficul de calcul N_{c15} m.o.s.
	2021	2026	2031	2036	
DN 6	998	1137	1404	1467	3.44
DN 59	858	1053	1288	1572	3.24
DJ 591	309	387	490	617	1.22
DJ 592	352	438	535	612	1.33
DJ 593	131	163	206	259	0.51

$N_c := 3.44$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1. Dimensionarea straturilor in alcatuirea sistemului rutier nou - pentru

DRUM NATIONAL - DN 6 E70

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (Metoda analitica) indicativ PD 177-2001

1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura MAS16
- 6 cm strat de legatura BAD20
- 12 cm strat de baza AB 31.5
- 30 cm strat superior de fundatie din piatra sparta amestec optimal
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

Modul de elasticitate dinamic Grosime Coeficientul lui Poisson

$E_t :=$

$h_t :=$

$\mu_t :=$

3600·MPa	4·cm	0.35
3000·MPa	6·cm	0.35
5000·MPa	12·cm	0.35
500·MPa	30·cm	0.27
216.18·MPa	30·cm	0.27
83·MPa	15·cm	0.27
65·MPa	$\frac{\infty}{2}$ ·m	0.30

P3 (tip pamant, teren de fundare)

1.2. Caracteristicile zonei

- tipul climateric I
- regimul hidrologic 2b corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P3 . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 65 MPa pentru tipul de pamant P3.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolanici



Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 83 MPa conform Fig. 2 pag. 52/PD 177, pentru grosimea de 15 cm strat de forma din balast.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modulului de elasticitate dinamic E_{balast} este in functie de cea a materialelor din stratul suport (din materiale granulare) E_p si se calculeaza cu relatia (3)

$h_{balast} := 300$ mm grosimea stratului de forma din balast

$E_p := 83$ MPa modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$$

$E_{balast} = 216.18$ MPa

coeficientul lui Poisson are valoarea: 0,27

$N_c := 3.44$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice orizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica orizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 103 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 4.27 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 4.36 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.789$$

$$RDO_{adm1} := 0.85 \quad \text{pentru drumuri europene}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 157 \quad \text{microdeformatii}$$

ϵ_{z1} deformatia specifica verticala de compresiune la nivelul pamantului de fundare

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 329 \cdot N_c^{-0.27} \quad \text{microdeformatii}$$

ϵ_{zadm1} deformatia specifica verticala admisibila la nivelul pamantului de fundare

$$\epsilon_{zadm1} = 235.68 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

DRUM: DN6

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm
Stratul 1: Modulul 4132. MPa, Coeficientul Poisson .350, Grosimea 22.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 3: Modulul 216. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 4: Modulul 83. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 65. MPa, Coeficientul Poisson .300 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-22.00	.584E+00	.103E+03	-.132E+03
.0	22.00	.200E-01	.103E+03	-.297E+03
.0	.00	-.104E+01	-.111E+03	.250E+02
.0	-97.00	.320E-02	.585E+02	-.133E+03
.0	97.00	.143E-02	.585E+02	-.157E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere

$n := 6$

$i := 1 \dots n$

1.1. Se propune urmatorul sistem rutier

$h_i :=$

$C_i :=$

- 4 cm strat de uzura din MAS16
 - 6 cm strat de legatura din BAD20
 - 12 cm strat de baza mixtura asfaltica AB31.5
 - 30 cm strat superior de fundatie din piatra sparta amestec optimal
 - 30 cm strat inferior de fundatie din balast
 - 15 cm strat de forma din balast
- P3 - (tip pamant, teren de fundare)

4·cm
6·cm
12·cm
30·cm
30·cm
15·cm

0.50
0.60
0.50
0.70
0.70
0.70

Coefficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 9'$$



Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 64.1 \cdot \text{cm}$$



Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 32.9 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 - 90, in functie de indicele de inghet I , tipul climatic si conditiile hidrologice.

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P3

adancimea de inghet 60-70 cm

$I_{med}^{3/30}$ 429 Timisoara

curba 3 - rezulta 70 cm adancime de inghet

Adancimea de inghet in pamantul de fundatie

$$Z_f := 85\text{cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 117.9\text{ cm}$$

Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}}$$

$$K = 0.548$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.50$$

pentru structuri rutiere suple

$$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$$



Drumul	Traficul MZA, osii standard 115 kN				Traficul de calcul N _c 15 m.o.s.
	2021	2026	2031	2036	
DN 6	998	1137	1404	1467	3.44
DN 59	858	1053	1288	1572	3.24
DJ 591	309	387	490	617	1.22
DJ 592	352	438	535	612	1.33
DJ 593	131	163	206	259	0.51

N_c := 3.24 m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1. Dimensionarea straturilor in alcatuirea sistemului rutier nou -

DN 59 E70

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (Metoda analitica)
indicativ PD 177-2001

Modul de elasticitate dinamic Grosime Coeficientul lui Poisson

1.1. Se propune urmatoarul sistem rutier

- 4 cm strat de uzura MAS16
- 6 cm strat de legatura BAD20
- 12 cm strat de baza AB 31.5
- 30 cm strat superior de fundatie din piatra sparta amestec optimal
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

E_t :=

h_t :=

μ_t :=

3600·MPa
3000·MPa
5000·MPa
500·MPa
216.18·MPa
83·MPa
65·MPa

4·cm
6·cm
12·cm
30·cm
30·cm
15·cm
∞·m
2

0.35
0.35
0.35
0.27
0.27
0.27
0.30

P3 (tip pamant, teren de fundare)

1.2. Caracteristicile zonei

- tipul climateric I
- regimul hidrologic 2b corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P3 . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 65 MPa pentru tipul de pamant P3.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolantici

Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 83 MPa conform Fig. 2 pag. 52/PD 177.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modulului de elasticitate dinamic **E_{balast}** este in functie de cea a materialelor din stratul suport (din materiale granulare) **E_p** si se calculeaza cu relatia (3)

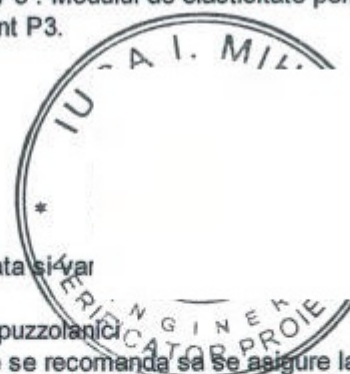
h_{balast} := 300 mm grosimea stratului de forma din balast

E_p := 83 MPa modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$$

E_{balast} = 216.18 MPa

coeficientul lui Poisson are valoarea: 0,27



$N_c := 3.24$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice horizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica horizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 103 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 4.27 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 4.36 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.743$$

$$RDO_{adm1} := 0.85 \quad \text{pentru drumuri europene}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 157 \quad \text{microdeformatii}$$

ϵ_{z1} deformatia specifica verticala de compresiune la nivelul pamantului de fundare

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 329 \cdot N_c^{-0.27} \quad \text{microdeformatii}$$

ϵ_{zadm1} deformatia specifica verticala admisibila la nivelul pamantului de fundare

$$\epsilon_{zadm1} = 239.52 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

DRUM: DN 59

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm
Stratul 1: Modulul 4132. MPa, Coeficientul Poisson .350, Grosimea 22.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 3: Modulul 216. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 4: Modulul 83. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 65. MPa, Coeficientul Poisson .300 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-22.00	.584E+00	.103E+03	-.132E+03
.0	22.00	.200E-01	.103E+03	-.297E+03
.0	.00	-.104E+01	-.111E+03	.250E+02
.0	-97.00	.320E-02	.585E+02	-.133E+03
.0	97.00	.143E-02	.585E+02	-.157E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere

$n := 6$

$i := 1 .. n$

1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura din MAS16
- 6 cm strat de legatura din BAD20
- 12 cm strat de baza mixtura asfaltica AB31.5
- 30 cm strat superior de fundatie din piatra sparta
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast
- P3 - (tip pamant, teren de fundare)

$h_i :=$

$C_i :=$

4·cm
6·cm
12·cm
30·cm
30·cm
15·cm

0.50
0.60
0.50
0.70
0.70
0.70

Coeficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 97 \cdot \text{cm}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 64.1 \cdot \text{cm}$$

Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 32.9 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 90, in functie de indicele de inghet I, tipul climatic si conditiile hidrologice.

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P3

adancimea de inghet 60-70 cm

$I_{med}^{3/30}$ 429 Timisoara

curba 3 - rezulta 70 cm adancime de inghet

Adancimea de inghet in pamantul de fundatie

$$Z_f := 85 \text{cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 117.9 \cdot \text{cm}$$



Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}} \quad K = 0.544$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$K_{adm} := 0.50$ pentru structuri rutiere suple

$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$



Drumul	Traficul MZA, osii standard 115 kN				Traficul de calcul N_{c15} m.o.s.
	2021	2026	2031	2036	
DN 6	998	1137	1404	1467	3.44
DN 59	858	1053	1288	1572	3.24
DJ 591	309	387	490	617	1.22
DJ 592	352	438	535	612	1.33
DJ 593	131	163	206	259	0.51

$N_c := 1.33$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1. Dimensionarea straturilor in alcatuirea sistemului rutier nou -

DJ 592, DJ D595D

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (Metoda analitica)
indicativ PD 177-2001

Modul de elasticitate dinamic Grosime Coeficientul
lui Poisson

1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura MAS16
- 6 cm strat de legatura BAD20
- 8 cm strat de baza AB 31.5
- 25 cm strat superior de fundatie din piatra sparta amestec optimal
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

$E_t :=$ $h_t :=$ $\mu_t :=$

3600·MPa	4·cm	0.35
3000·MPa	6·cm	0.35
5000·MPa	8·cm	0.35
500·MPa	25·cm	0.27
216.18·MPa	30·cm	0.27
83·MPa	15·cm	0.27
65·MPa	$\frac{\infty}{2}$ ·m	0.30

P3 (tip pamant, teren de fundare)

1.2. Caracteristicile zonei

- tipul climateric I
- regimul hidrologic 2b corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P3 . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 65 MPa pentru tipul de pamant P3.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolanici

Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 83 MPa conform Fig. 2 pag. 52/PD 177.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modului de elasticitate dinamic E_{balast} este in functie de cea a materialelor din stratul suport (din materiale granulare) E_p si se calculeaza cu relatia (3)

$$h_{balast} := 300 \text{ mm} \quad \text{grosimea stratului de forma din balast}$$

$E_p := 83 \text{ MPa}$ modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$$

$$E_{balast} = 216.18 \text{ MPa}$$



coeficientul lui Poisson are valoarea: 0,27

$N_c := 1.33$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice orizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica orizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 130 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 4.27 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 1.73 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.769$$

$$RDO_{adm1} := 1.00 \quad \text{pentru drumuri judetene}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 201 \quad \text{microdeformatii}$$

ϵ_{z1} deformatia specifica verticala de compresiune la nivelul pamantului de fundare

Pentru drumuri cu trafic de calcul mai mare de 1 m.o.s. ($N_c > 1$ m.o.s.) deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 329 \cdot N_c^{-0.27} \quad \text{microdeformatii}$$

ϵ_{zadm1} deformatia specifica verticala admisibila la nivelul pamantului de fundare

$$\epsilon_{zadm1} = 304.62 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

DRUM: DJ 592, DJ 595D

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm

Stratul 1: Modulul 3954. MPa, Coeficientul Poisson .350, Grosimea 18.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .270, Grosimea 25.00 cm
Stratul 3: Modulul 216. MPa, Coeficientul Poisson .270, Grosimea 30.00 cm
Stratul 4: Modulul 83. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 65. MPa, Coeficientul Poisson .300 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-18.00	.693E+00	.130E+03	-.169E+03
.0	18.00	.213E-01	.130E+03	-.390E+03
.0	.00	-.120E+01	-.143E+03	.551E+02
.0	-88.00	.419E-02	.757E+02	-.171E+03
.0	88.00	.191E-02	.757E+02	-.201E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere
1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura din MAS16
- 6 cm strat de legatura din BAD20
- 8 cm strat de baza mixtura asfaltica AB31.5
- 25 cm strat superior de fundatie din piatra sparta
- 30 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast
- P3 - (tip pamant, teren de fundare)

$n := 6$

$i := 1 \dots n$

$h_i :=$

$C_i :=$

4·cm
6·cm
8·cm
25·cm
30·cm
15·cm

0.50
0.60
0.50
0.70
0.70
0.70

Coeficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 88 \cdot \text{cm}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 58.6 \cdot \text{cm}$$

Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 29.4 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 90, in functie de indicele de inghet I, tipul climatic si conditiile hidrologice

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P3

adancimea de inghet 60-70 cm

$I_{med}^{3/30}$ 429 Timisoara

curba 3 - rezulta 70 cm adancime de inghet

Adancimea de inghet in pamantul de fundatie

$$Z_f := 85 \text{cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 114.4 \cdot \text{cm}$$



Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}} \quad K = 0.512$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.50 \quad \text{pentru structuri rutiere suple}$$

$$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$$



Drumul	Traficul MZA, osii standard 115 kN				Traficul de calcul N_{c15} m.o.s.
	2021	2026	2031	2036	
DN 6	998	1137	1404	1467	3.44
DN 59	858	1053	1288	1572	3.24
DJ 591	309	387	490	617	1.22
DJ 592	352	438	535	612	1.33
DJ 593	131	163	206	259	0.51

$N_c := 0.51$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1. Dimensionarea straturilor in alcatuirea sistemului rutier nou -

DJ 593

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (Metoda analitica) indicativ PD 177-2001

1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura MAS16
- 6 cm strat de legatura BAD20
- 8 cm strat de baza AB 31.5
- 15 cm strat superior de fundatie din piatra sparta amestec optimal
- 25 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

Modul de elasticitate dinamic Grosime Coeficientul lui Poisson

$E_t :=$ $h_t :=$ $\mu_t :=$

3600·MPa	4·cm	0.35
3000·MPa	6·cm	0.35
5000·MPa	8·cm	0.35
500·MPa	15·cm	0.27
199.15·MPa	25·cm	0.27
83·MPa	15·cm	0.27
65·MPa	$\frac{\infty}{2}$ ·m	0.30

P3 (tip pamant, teren de fundare)

1.2. Caracteristicile zonei

- tipul climateric I
- regimul hidrologic 2b

corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P3 . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 65 MPa pentru tipul de pamant P3.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolanici

Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 83 MPa conform Fig. 2 pag. 52/PD 177.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modulului de elasticitate dinamic E_{balast} este in functie de cea a materialelor din stratul suport (din materiale granulare) E_p si se calculeaza cu relatia (3)

$h_{balast} := 250$ mm grosimea stratului de forma din balast

$E_p := 83$ MPa modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$$



$$E_{balast} = 199.15 \quad \text{MPa}$$

coeficientul lui Poisson are valoarea: 0,27

$$N_c := 0.51 \quad \text{m.o.s.} \quad \text{perioada de perspectiva 15 ani} \quad 2021 - 2036$$

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice orizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica orizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 140 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul cel mult egal 1 m.o.s. numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 24.5 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 7.4 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.069$$

$$RDO_{adm1} := 1.00 \quad \text{pentru drumuri judetene}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 284 \quad \text{microdeformatii}$$

$$\epsilon_{z1} \quad \text{deformatia specifica verticala de compresiune la nivelul pamantului de fundare}$$

Pentru drumuri cu trafic cel mult egal cu 1 m.o.s. deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 600 \cdot N_c^{-0.28} \quad \text{microdeformatii}$$

$$\epsilon_{zadm1} \quad \text{deformatia specifica verticala admisibila la nivelul pamantului de fundare}$$

$$\epsilon_{zadm1} = 724.49 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

DRUM: DJ 593

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm

Stratul 1: Modulul 3954. MPa, Coeficientul Poisson .350, Grosimea 18.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .350, Grosimea 15.00 cm
Stratul 3: Modulul 199. MPa, Coeficientul Poisson .270, Grosimea 25.00 cm
Stratul 4: Modulul 83. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 65. MPa, Coeficientul Poisson .270 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-18.00	.813E+00	.148E+03	-.185E+03
.0	18.00	.264E-01	.148E+03	-.362E+03
.0	.00	-.131E+01	-.160E+03	.742E+02
.0	-73.00	.549E-02	.103E+03	-.239E+03
.0	73.00	.294E-02	.103E+03	-.284E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere
1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura din MAS16
- 6 cm strat de uzura din BAD20
- 8 cm strat de baza mixtura asfaltica AB31.5
- 15 cm strat superior de fundatie din piatra sparta
- 25 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast
- P3 - (tip pamant, teren de fundare)

$n := 6$

$i := 1 .. n$

$h_i :=$

$C_i :=$

4·cm
6·cm
8·cm
15·cm
25·cm
15·cm

0.50
0.60
0.50
0.70
0.70
0.70

Coeficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 73 \cdot \text{cm}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 48.1 \cdot \text{cm}$$

Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 24.9 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 - 90, in functie de indicele de inghet I, tipul climatic si conditiile hidrologice.

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P3

adancimea de inghet 60-70 cm

$I_{med}^{5/30}$ 319 Timisoara

curba 3 - rezulta 70 cm adancime de inghet

Adancimea de inghet in pamantul de fundatie

$$Z_f := 70 \text{ cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 94.9 \cdot \text{cm}$$



Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}}$$

$$K = 0.507$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.50$$

pentru structuri rutiere suple

$$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$$



Anul	2021	2026	2031	2036
MZA osii 155 kN	42	51	65	76
Traficul de calcul Nc15	0.16 m.o.s.			

Nc := 0.16 m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1. Dimensionarea straturilor in alcatuirea sistemului rutier nou - DRUMURI COMUNALE, Strazi

- conform Normativului pentru dimensionarea sistemelor rutiere suple si semirigide (Metoda analitica)
indicativ PD 177-2001

Modul de elasticitate
dinamic Grosime Coeficientul
lui Poisson

1.1. Se propune urmatoarul sistem rutier

- 4 cm strat de uzura MAS16
- 8 cm strat de baza AB 31.5
- 20 cm strat superior de fundatie din piatra sparta amestec optimal
- 25 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast

P3 (tip pamant, teren de fundare)

$E_t :=$

$h_t :=$

$\mu_t :=$

3300·MPa
5000·MPa
500·MPa
199.15·MPa
83·MPa
65·MPa

4·cm
8·cm
20·cm
25·cm
15·cm
$\frac{\infty}{2}$ ·m

0.35
0.35
0.27
0.27
0.27
0.30

1.2. Caracteristicile zonei

- tipul climateric
- regimul hidrologic

I

2b corespunzator conditiilor hidrologice favorabile conform STAS 1709/2

- pamantul care va constitui fundatia structurii rutiere este de tip P3 . Modulul de elasticitate pentru tipul climatic I, regim hidrologic 2b este 65 MPa pentru tipul de pamant P3.

Straturile de forma pot fi alcatuite din:

- materiale necoezive:
 - pamanturi necoezive
 - materiale granulare
 - deseuri de cariera
 - zgura bruta de furnal inalt
- materiale coezive:
 - pamanturi coezive tratate cu var
 - pamanturi stabilizate cu zgura granulata si var
 - pamanturi stabilizate cu ciment
 - agregate naturale stabilizate cu lianti puzzolanici

Pentru folosirea rationala a agregatelor naturale in straturile de fundatie se recomanda sa se asigure la nivelul patului drumului o capacitate portanta minima, caracterizata prin valoarea modulului de elasticitate dinamic echivalent al sistemului bistrat (strat de forma - pamant de fundare).

Valoarea modulului de elasticitate dinamic la nivelul superior al stratului de forma va fi de minim 83 MPa conform Fig. 2 pag. 52/PD 177.

Caracteristicile de deformabilitate ale materialelor din stratul inferior de fundatie sunt in functie de tipul acestora, si anume:

pentru materiale necoezive: valoarea de calcul a modului de elasticitate dinamic E_{balast} este in functie de cea a materialelor din stratul suport (din materiale granulare) E_p si se calculeaza cu relatia (3)

$h_{balast} := 250 \text{ mm}$ ——— grosimea stratului de forma din balast ———

$E_p := 83 \text{ MPa}$

modulul de elasticitate dinamic al stratului de forma din balast de 15 cm grosime

$E_{balast} := 0.20 \cdot h_{balast}^{0.45} \cdot E_p \quad (3)$

$E_{balast} = 199.15 \text{ MPa}$

coeficientul lui Poisson are valoarea: 0,27



$N_c := 0.51$ m.o.s. perioada de perspectiva 15 ani 2021 – 2036

1.3. Stabilirea comportarii sub trafic a sistemului rutier - calculul deformatiei specifice orizontale de intindere la baza straturilor bituminoase si a deformatiei specifice verticale de compresiune la nivelul patului drumului

1.3.1. Criteriul deformatiei specifice de intindere admisibile la baza straturilor bituminoase

Deformatia specifica orizontala de intindere la baza straturilor bituminoase rezultata din calcul cu programul CALDEROM este

$$\epsilon_{r1} := 174 \quad \text{microdeformatii}$$

Pentru drumuri cu trafic de calcul cel mult egal 1 m.o.s. numarul de solicitari admisibil care poate fi preluat de straturile bituminoase se stabileste cu relatia:

$$N_{adm1} := 24.5 \cdot 10^8 \cdot \epsilon_{r1}^{-3.97} \quad \text{mos}$$

$$N_{adm1} = 3.12 \quad \text{mos}$$

Rata de degradare din oboseala:

$$RDO_1 := \frac{N_c}{N_{adm1}} \quad RDO_1 = 0.163$$

$$RDO_{adm1} := 1.00 \quad \text{pentru drumuri comunale}$$

$$\text{Expresie}(RDO_{adm1} \geq RDO_1) = \text{"Adevarat"}$$



1.3.3. Criteriul deformatiei specifice verticale admisibile la nivelul pamantului de fundare:

Deformatia specifica verticala de compresiune la nivelul terenului rezultata din calcul cu programul CALDEROM este:

$$\epsilon_{z1} := 324 \quad \text{microdeformatii}$$

ϵ_{z1} deformatia specifica verticala de compresiune la nivelul pamantului de fundare

Pentru drumuri cu trafic cel mult egal cu 1 m.o.s. deformatia specifica verticala de compresiune admisibila la nivelul pamantului de fundare se calculeaza cu relatia:

$$\epsilon_{zadm1} := 600 \cdot N_c^{-0.28} \quad \text{microdeformatii}$$

ϵ_{zadm1} deformatia specifica verticala admisibila la nivelul pamantului de fundare

$$\epsilon_{zadm1} = 724.49 \quad \text{microdeformatii}$$

$$\text{Expresie}(\epsilon_{zadm1} \geq \epsilon_{z1}) = \text{"Adevarat"}$$

DRUM:

Sector omogen:

Parametrii problemei sunt

Sarcina..... 57.50 kN
Presiunea pneului 0.625 MPa
Raza cercului 17.11 cm

Stratul 1: Modulul 4499. MPa, Coeficientul Poisson .350, Grosimea 12.00 cm
Stratul 2: Modulul 500. MPa, Coeficientul Poisson .350, Grosimea 20.00 cm
Stratul 3: Modulul 199. MPa, Coeficientul Poisson .270, Grosimea 25.00 cm
Stratul 4: Modulul 83. MPa, Coeficientul Poisson .270, Grosimea 15.00 cm
Stratul 5: Modulul 65. MPa, Coeficientul Poisson .270 si e semifinit

REZULTATE:

R	Z	sigma r	epsilon r	epsilon z
cm	cm	MPa	microdef	microdef
.0	-12.00	.106E+01	.174E+03	-.225E+03
.0	12.00	-.143E-01	.174E+03	-.530E+03
.0	.00	-.176E+01	-.206E+03	.135E+03
.0	-72.00	.648E-02	.119E+03	-.273E+03
.0	72.00	.354E-02	.119E+03	-.324E+03



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET



SISTEM RUTIER NOU SUPLU

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere
1.1. Se propune urmatorul sistem rutier

- 4 cm strat de uzura din MAS16
- 8 cm strat de baza mixtura asfaltica AB31.5
- 20 cm strat superior de fundatie din piatra sparta
- 25 cm strat inferior de fundatie din balast
- 15 cm strat de forma din balast
- P3 - (tip pamant, teren de fundare)

$n := 6$

$i := 1 .. n$

$h_i :=$

$C_i :=$

4·cm
8·cm
20·cm
25·cm
15·cm

0.50
0.50
0.70
0.70
0.70

Coeficientul de echivalare C_i a capacitatii de transmitere a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 72 \cdot \text{cm}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 48 \cdot \text{cm}$$

Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 24 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 - 90, in functie de indicele de inghet I , tipul climatic si conditiile hidrologice,

tip climatic I

conditii hidrologice defavorabile 2b

tip de pamant P3

adancimea de inghet 60-70 cm

$I_{med}^{5/30}$ 319 Timisoara

curba 3 - rezulta 70 cm adancime de inghet



Adancimea de inghet in pamantul de fundatie

$$Z_f := 70\text{cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 94\text{cm}$$

Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}}$$

$$K = 0.511$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.50 \quad \text{pentru structuri rutiere suple}$$

$$\text{Expresie}(K \geq K_{adm}) = \text{"Adevarat"}$$

Intocmit

ing. Cosmin Paul



DIMENSIONAREA SISTEMULUI RUTIER NOU RIGID conform NP 081-2002

PARCARE DE SCURTA DURATA km 10+670 stanga si 19+870 dreapta

Principii de dimensionare

Dimensionarea structurilor rutiere rigide se bazeaza pe criteriul tensiunii la intindere din incovoiere admisibila a betonului σ_{adm}

Pentru dimensionarea structurilor rutiere rigide este necesar sa se efectueze in prealabil studii in vederea obtinerii urmatoarelor date:

- compozitia, intensitatea si evolutia in perspectiva a traficului
- caracteristicile geotehnice ale pamantului de fundare
- regimul hidrologic al complexului rutier

Schema de calcul din cadrul metodei de dimensionare este modelul cu element finit realizat prin procedeul multistrat, alcatuit din: dala din beton de ciment si stratul echivalent straturilor reale subadiacente dalei (strat de fundatie/strat de forma si pamant de fundare) in conditiile urmatoarelor ipoteze:

- caracteristicile incarcarii din trafic (osia standard de 115kN) sunt:

- incarcarea pe rotile duble: 57,5 kN
- presiunea in amprenta: 0,625 MPa
- coeficientul de impact: 1,2
- presiunea de calcul in amprenta: $0,625 \text{ MPa} \times 1,2 = 0,750 \text{ MPa}$

- incarcarea de calcul din trafic este incarcarea pe rotile duble a osiei standard de 115 kN sporita cu coeficientul de impact si transmisa printr-o amprenta dreptunghiulara, tangenta la marginea dalei, echivalenta amprenteii eliptice reale avand dimensiunile in plan: $L \times l = 37 \times 25 \text{ (cm)}$

- incarcarea din variatii zilnice de temperatura este datorata gradientului zilnic de temperatura constant, egal cu 0,67 din grosimea dalei: - dala reazema uniform pe stratul de fundatie

- deplasările la contactul dintr dala si stratul echivalent straturilor reale

subadiacente sunt definite prin modulul de reactie la suprafata stratului de fundatie.

Etape principale:

Stabilirea traficului de calcul

Stabilirea capacitatii portante a pamantului de fundare

Alcatuirea structurii rutier

Stabilirea capacitatii portante la nivelul stratului de fundatie

Calculul grosimii dalei din beton de ciment

Stabilirea traficului de calcul in osii de 115kN

Autocamioane si derivate cu 2 osii: 11

Autocamioane si derivate cu 3 osii sau 4 osii: 22

Autovehicule articulate: 11

Autobuze: 3

Remorci: 3

(locuri parcare 11)

$p_p := 30$

perioada de perspectiva (ani) 2020- 2050

$c_{rt} := 0.50$

coeficientul de repartitie transversala, pe benzi de circulatie

Tabelul 7.

Coeficientul de repartitie transversala

Numarul benzilor de circulatie pe profil transversal	1	2	3	4
c_{rt}	1,00	0,50	0,50	0,45

MZA_k

traficul mediu zilnic anual al vehiculelor fizice din grupa k, conform rezultatelor recensamantului general de circulatie sau studiului de trafic

p_k

coeficientul de evolutie al vehiculelor k in anul de la mijlocul perioadei de perspectiva stabilit prin interpolare 2030

f_{ek}

coeficientul de echivalare a vehiculelor fizice din grupa k in osii standard



Tipuri de structuri rutiere	Grupe de vehicule					
	Autocamioane si derivate cu 2 osii	Autocamioane si derivate cu 3-4 osii	Autovehicule articulate	Autobuze	Tractoare cu remorci	Tren rutier
Rigide	0.2	2.6	1.5	2	0.2	1.4

Grupe de vehicule	Traficul mediu zilnic	Pk	fek	MZAk x pk x fek
Autocamioane si derivate cu 2 osii	11	2.36	0.2	5.19
Autocamioane si derivate cu 3 osii sau 4 osii	22	2.56	2.6	146.43
Autovehicule articulate	11	2.34	1.5	38.61
Autobuze	3	1.94	2	11.64
Remorci	3	2.86	0.2	1.72
Total o.s. 115 = $\sum MZA_k \times p_k \times f_{ek}$				203.59

$$N_c := 365 \cdot 10^{-6} \cdot p_p \cdot c_{rt} \cdot \sum_{k=1}^5 (MZA_k \cdot p_k \cdot f_{ek})$$

$$N_c := 365 \cdot 10^{-6} \cdot p_p \cdot c_{rt} \cdot 103.59$$

$$N_c = 0.57 \text{ mos}$$

Stabilirea capacitatii portante a pamantului

Stabilirea valorii modulului de reactie al pamantului de fundare K_0

- prin incercari cu placa in situ (Anexa 2)
- prin corelarea cu rezultatele altor incercari de determinare a capacitatii portante a pamantului de fundare

Ep (MPa) modulul de elasticitate dinamic al pamantului de fundare
CBR (%) indicele de portanta californian

Caracteristicile zonei

tip climateric: I
regim hidrologic: 1
tip de pamant: P4

$$E_p := 10 \cdot CBR$$

$$K_0 := 8.75 + 6.75 \cdot CBR + 0.20238 \cdot CBR^2$$

$$K_0 := 50 \frac{MN}{m^3} \text{ din tabelul 8}$$



Alcatuirea structurii rutiere

In functie de clasa tehnica a drumului, structurile rutiere rigide sunt alcatuite in urmatoarele variante:

a. imbracaminte din dale de beton de ciment realizata dintr-un singur strat sau doua straturi, strat de fundatie superior, strat de fundatie inferior, eventual strat de forma.

Aceasta varianta este obligatorie pentru drumurile de clasa tehnica I si II, iar pentru drumurile de clasa tehnica III.....V se stabileste pe baza de calcul tehnico-economic

b. imbracaminte din dale de beton de ciment realizata dintr-un singur strat sau doua straturi, strat de fundatie, eventual strat de forma.

Aceasta varianta se foloseste pentru drumurile de clasa tehnica III.....V

Grosimea minima a imbracamintel din beton de ciment este de 18 cm

Am ales:

- strat de fundatie superior din piatra sparta: 20 cm
- strat de fundatie inferior din balast: 30 cm
- strat de forma din materiale granulare 25 cm

Stabilirea capacitatii portante la nivelul stratului de fundatie

Capacitatea portanta la nivelul stratului de fundatie este exprimata prin modulul de reactie la suprafata stratului de fundatie, K ce se determina in functie de:

- valoarea modulului de reactie al pamantului de fundare K_0

- grosimea echivalenta a stratului de fundatie/forma, Hech (reprezinta suma grosimilor echivalente ale acestora, conform relatiei:

n - numarul de straturi

h_i grosimea efectiva a stratului i

a_i coeficient de echivalare a stratului i, determinat cu relatia (3) sau din tabelul 11

n := 3 i := 1 .. n

$h_i :=$ $a_i :=$

20·cm	1.0
30·cm	0.75

$$\text{Hech} := \sum_{i=1}^n (h_i \cdot a_i) \quad (\text{cm}) \quad \text{relatia (2)}$$

$$\text{Hech} = 0.425 \text{ m}$$



Valorile coeficientului de echivalare a_i , ale straturilor

Mixtura asfaltica	1,5
Balast stabilizat cu lianji hidraulici (ciment) / lianti puzzolanici (zgura granulata, cenusa de termocentrala)	1.5
Piatra sparta	1,0
Nisip stabilizat cu lianti hidraulici (ciment) / lianti puzzolanici (zgura granulata, cenusa de termocentrala)	1,0
Balast	0.75
Nisip	0,50

relatia (3)

$$a_i := \left(\frac{E_i}{500} \right)^{\frac{1}{3}}$$

E_i modulul de elasticitate dinamic al materialului din stratul i, determinat conform indicativ PD 177-2001

500 valoarea modulului de elasticitate al stratului etalon (din piatra sparta)

Valoarea modului de reacție la suprafața stratului de fundație, K se obține:

- pentru valorile modului de reacție al pământului de fundare K_0 cuprinse între 20 MN/m^3 și 100 MN/m^3 și valoarea grosimii echivalente stratului de fundație/formă, H_{ech} , obținută cu relația (2),

folosind diagrama din figura 3.

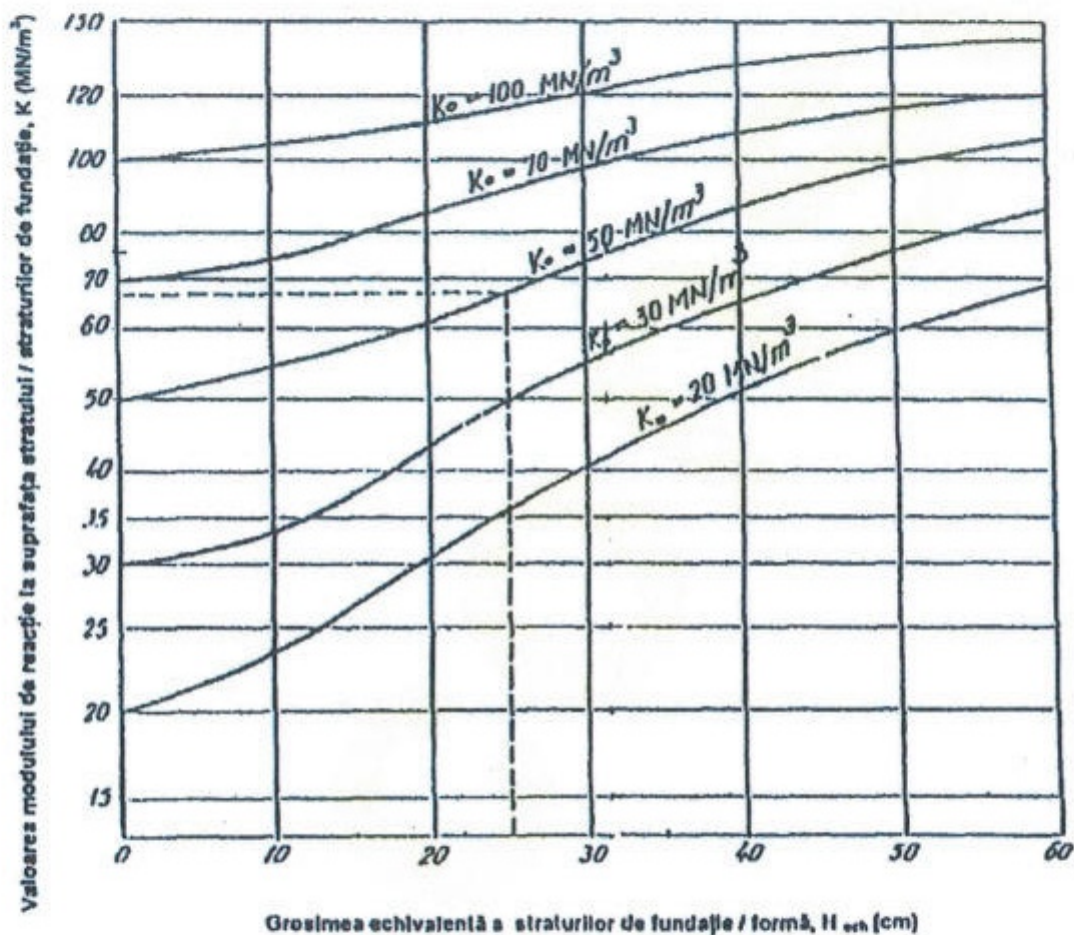


Fig. 3. – Modul de reacție la suprafața stratului de fundație

pentru ca:

$$H_{ech} = 0.425 \text{ m}$$

$$K_0 := 50 \frac{\text{MN}}{\text{m}^3} \quad \text{din tabelul 8}$$

$$\text{din diagrama rezulta } K: \quad 90 \frac{\text{MN}}{\text{m}^3}$$

$$K := 90$$



Calculul grosimii dalei din beton de ciment

Caracteristicile betonului de ciment rutier:
- rezistența caracteristică la încovoiere R
Am ales beton de ciment rutier BcR 4

Tabelul 12.

Clasa betonului rutier	BcR 3,5	BcR 4,0	BcR 4,5	BcR 5,0
Rezistența caracteristică la încovoiere, R_{inc}^k . Determinată la 28 de zile pe prisme de 150 x 150 x 600 mm, conform prescripțiilor tehnice în vigoare, MPa	3,5	4,0	4,5	5,0

Tensiunea la întindere din încovoiere admisibilă a betonului σ_{adm}

$E := 30000$ MPa modulul de elasticitate la solicitări de scurtă durată (din trafic)

$\nu := 0.15$ coeficientul lui Poisson

$\rho := 2400 \frac{\text{kg}}{\text{m}^3}$ densitatea aparentă

modulul de elasticitate la solicitări de lungă durată (din gradientul de temperatură)

$0.5 \cdot E = 15000$ MPa

Criteriul de dimensionare

Dimensionarea structurilor rutiere rigide se bazează pe criteriul tensiunii la întindere din încovoiere admisibilă a betonului σ_{adm} și se exprimă prin relația:

$$\sigma_1 \leq \sigma_{adm1}$$

σ_1 tensiunea la întindere din încovoiere a betonului din dale determinată pe baza ipotezelor de dimensionare

σ_{adm1} tensiunea la întindere din încovoiere admisibilă a betonului de ciment din dale (dacă dalele sunt realizate din două straturi σ_{adm1} se referă la betonul din stratul de rezistență)

Tensiunea la întindere din încovoiere admisibilă a betonului de ciment rutier se determină cu relația:

Am ales beton de ciment rutier BcR 4,0

$R := 4$ rezistența caracteristică la încovoiere a betonului la 28 de zile (SR 183-1:1995)

$\alpha := 1.1$ coeficient de creștere a rezistenței betonului în intervalul 28....90 zile

$\gamma := 0.05$ coeficient

N_c traficul de calcul pe perioada de perspectivă, exprimat în m.o.s.

$0.70 - \gamma \cdot \log N_c$ legea de oboseală

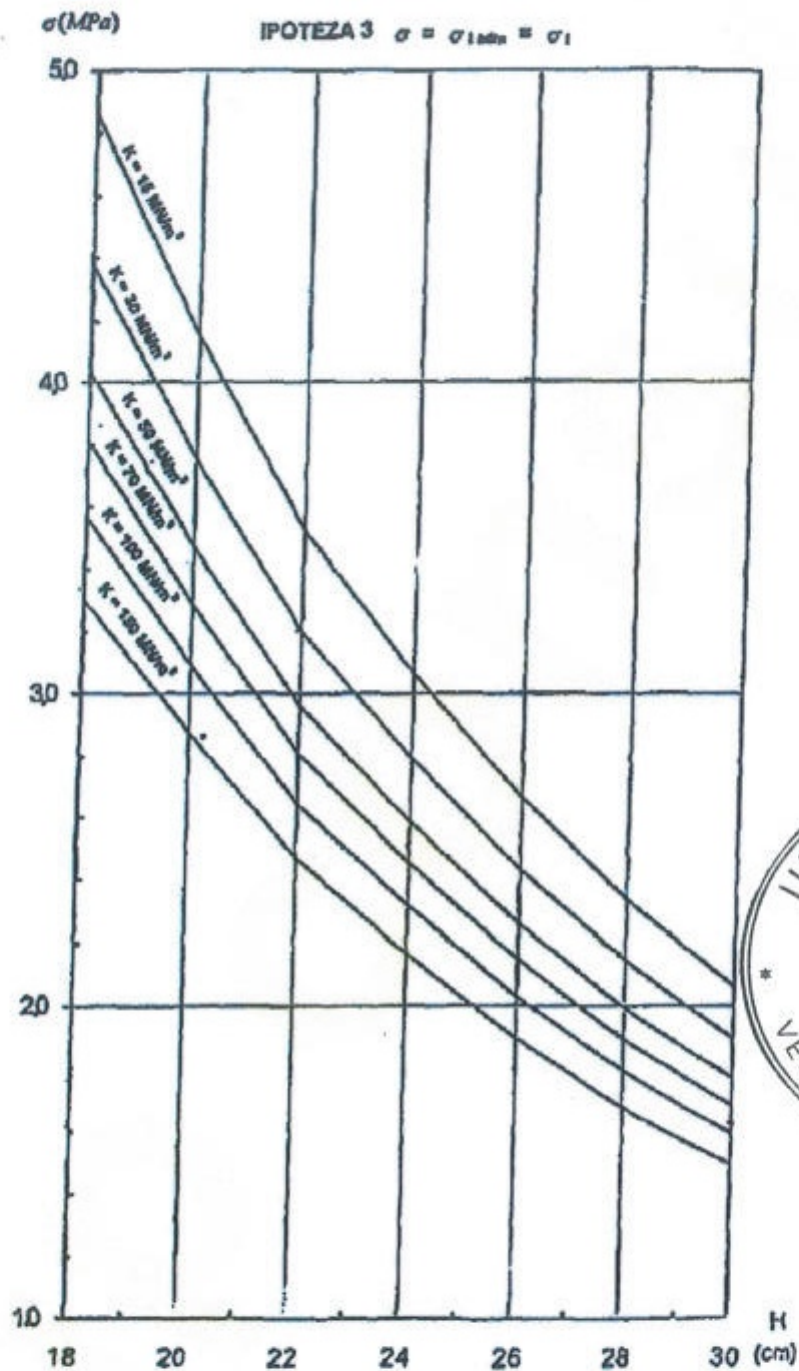
$\sigma_{adm1} := R \cdot \alpha \cdot (0.70 - \gamma \cdot \log(N_c))$ MPa

$\sigma_{adm1} = 3.13$ MPa



Adoptarea ipotezei de dimensionare:

am adoptat IPOTEZA 3



$$k := 90 \frac{\text{MN}}{\text{m}^3}$$

$$\sigma_{adm1} = 3.13 \text{ MPa}$$

Grosimea dalei de beton, H rezulta egala cu 19,9 cm se rotunjeste la 20 cm

Deci sistemul rutier care asigura o capacitate portanta corespunzatoare este urmatorul:

- | | |
|---|-------|
| - imbracaminte din beton de ciment rutier BcR 4 | 20 cm |
| - strat de fundatie superior din piatra sparta: | 20 cm |
| - strat de fundatie inferior din balast: | 30 cm |
| - strat de forma din agregate naturale | 25 cm |



VERIFICAREA SISTEMULUI RUTIER LA INGHET-DEZGHET

Adancimea de inghet in complexul rutier necesara la verificarea rezistentei sistemului rutier la actiunea fenomenului de inghet - dezghet se calculeaza conform STAS 1709/1 - 90

Numar de straturi rutiere

$n := 4$

$i := 1 \dots n$

$h_i :=$

$C_i :=$

- imbracaminte din beton de ciment
rutier BcR 4

20 cm

20·cm

0.45

- strat de fundatie din piatra sparta :

20 cm

20·cm

0.70

- strat de fundatie inferior din balast:

30 cm

30·cm

0.70

- strat de forma agregate naturale

25 cm

25·cm

0.70

Coeficientul de echivalare C_i a capacitatii de transmite

re a caldurii specifice fiecarui material din alcatuirea sistemului rutier se alege din tabelul 3 STAS 1709/1-90

Grosimea totala a sistemului rutier H_{sr}

$$H_{sr} := \sum_{i=1}^n h_i$$

$$H_{sr} = 1 \text{ m}$$

Grosimea echivalenta totala a sistemului rutier H_e

$$H_e := \sum_{i=1}^n (h_i \cdot C_i)$$

$$H_e = 62 \cdot \text{cm}$$



Adancimea de inghet in complexul rutier Z_{cr} se considera egala cu adancimea de inghet in pamantul de fundatie Z_f , stabilita in conditii de porozitate si umiditate specifice acestuia, la care se adauga un spor al adancimii de inghet ΔZ determinat de capacitatea de transmitere a caldurii de straturile din alcatuirea sistemului rutier

$$\Delta Z := H_{sr} - H_e$$

$$\Delta Z = 33 \cdot \text{cm}$$

Adancimea de inghet in pamantul de fundatie Z_f se stabileste pe baza curbelor din fig.1 STAS 1709/1 - 90, in functie de indicele de inghet I , tipul climatic si conditiile hidrologice.

tip climatic I

conditii hidrologice nefavorabile

tip de pamant P4

adancimea de inghet 60-70 cm

I_{\max}^{30} 478 valoarea maxima a indicelui de inghet

CURBA 4 - STAS 1709/1

adancimea de inghet - 70 - 80 cm conform STAS 6054-77

D

Adancimea de inghet in pamantul de fundatie

$$Z_f := 84 \text{ cm}$$

$$Z_{cr} := Z_f + \Delta Z$$

$$Z_{cr} = 117 \cdot \text{cm}$$

Se considera ca o structura rutiera este rezistenta la inghet - dezghet, daca gradul de asigurare la patrunderea inghetului in complexul rutier K este mai mare sau egal cu K_{adm}

$$K := \frac{H_e}{Z_{cr}}$$

$$K = 0.52$$

K_{adm} se stabileste din tabelul 4 STAS 1709/2 - 90 in functie de gradul de sensibilitate si tipul pamantului, tipul climatic si natura straturilor din sistemul rutier.

$$K_{adm} := 0.30$$

Expresie ($K \geq K_{adm}$) = "Adevarat"

Intocmit:



Varianta de ocolire Timisoara – Sud

Studiu de trafic

Determinarea traficului de calcul pentru dimensionarea structurilor rutiere



Cuprins

1. Obiective
2. Traficul de calcul pentru Varianta de ocolire Timisoara – Sud
3. Traficul de calcul pentru dimensionarea structurilor rutiere suple si semirigide pe drumurile intersectate de Varianta de ocolire
4. Concluzii
5. Bibliografie

Anexe

Anexa 1 Date de trafic furnizate de beneficiar



1. Obiective

Varianta de ocolire Timisoara – Sud se desfasoara in partea de Sud a municipiului Timisoara, incepand de la piciorul rampei Sud a podului peste canalul Bega, intersecteaza DN59 dupa care se indreapta spre partea de est a municipiului, pana la DN6. Varianta de ocolire urmeaza a avea o lungime de 25,690 Km.

Obiectivul prezentului studiu de trafic este determinarea traficului de calcul pentru dimensionarea structurilor rutiere pentru:

- Varianta de ocolire Timisoara – Sud
- Amenajarea intersectiilor cu drumuri nationale, judetene si comunale intersectate de varianta de ocolire.



2. Traficul de calcul pentru varianta de ocolire Timisoara – Sud

Pentru dimensionarea structurii rutiere pe Varianta de ocolire Timisoara – Sud, este necesara determinarea traficului de calcul, exprimat in osii standard de 115 kN.

Sucesiunea operatiilor pentru determinarea traficului de calcul este urmatoarea:

- Sursa datelor de trafic
- Stabilirea elementelor temporale:
 - Anul de baza al traficului
 - Anul de dare in exploatare a Variantei de ocolire
- Sectorizarea variantei de ocolire din punct de vedere al variantei intensitatii si structurii traficului
- Prognoza de evolutie a traficului
- Echivalarea traficului de vehicule fizice in osii de 115 kN
- Determinarea traficului de calcul pe sectoarele variantei de ocolire

Datele de trafic de prognoza pe sectoarele Variantei de ocolire au fost furnizate de beneficiar CNAIR – SA care a pus la dispozitie urmatoarele documentatii:

- Studiul de trafic pentru Varianta de ocolire Timisoara – Sud, revizuit de CESTRIN in anul 2018
- Completarile la studiul de trafic, solicitate, privind valorile de trafic pentru grupa de vehicule comerciale, la orizontul de trafic 2020 – 2040, pe categoriile de vehicule componente.

Elementele temporare stabilite prin studiul de trafic revizuit sunt:

- Anul de baza pentru estimarea prognozei de trafic: 2015
- Anul estimat de dare in exploatare a Variantei de ocolire: 2021

Din punct de vedere al traficului, varianta de ocolire a fost impartita in trei sectoare, delimitate de principalele noduri rutiere.

Prognoza de evolutie a traficului, stabilita pe baza ultimelor date furnizate de beneficiar, pentru sectoarele Variantei de ocolire, pe perioada de perspectiva 2020 – 2040, pe categorii de vehicule, este prezentata in tabelul 1.

Prognoza de evolutie a traficului, considerand anul de dare in exploatare al variantei de ocolire 2021, este prezentata in tabelul 2.



Proгноza traficului pe sectoarele Variantei de ocolire Timisoara – Sud pe baza datelor furnizate de beneficiar

Tabelul 1

Sectorul de drum	Anul	MZA pe grupe de vehicule			
		Autoturisme	Autocamioane 2 osii	Autocamioane 3-4 osii	Vehicule articulate
DJ591 - DN59	2020	6539	90	26	257
	2025	7067	98	27	269
	2030	7645	119	31	332
	2035	9158	143	37	407
	2040	10799	168	43	489
DN59 - DJ592	2020	2789	105	204	1048
	2025	2996	115	211	1099
	2030	3213	136	245	1356
	2035	3829	161	290	1665
	2040	4497	188	333	2005
DJ592 - DN6	2020	1671	263	293	1103
	2025	1802	286	248	1156
	2030	1945	342	287	1426
	2035	2325	408	339	1745
	2040	2738	477	390	2100



Proгноza traficului pe sectoarele Variantei de ocolire Timisoara – Sud plecand de la anul 2021 de dare in exploatare al Variantei de ocolire

Tabelul 2

Sectorul de drum	Anul	MZA pe grupe de vehicule			
		Autoturisme	Autocamioane 2 osii	Autocamioane 3-4 osii	Vehicule articulate
DJ591 - DN59	2021	6641	92	26	259
	2026	7179	102	28	281
	2031	7926	123	32	346
	2036	9465	148	38	422
	2041	9807	172	44	507
DN59 - DJ592	2021	2829	107	205	1058
	2026	3038	119	217	1146
	2031	3328	141	253	1413
	2036	3954	166	298	1728
	2041	4095	194	342	2081
DJ592 - DN6	2021	1696	267	241	1113
	2026	1830	296	255	1206
	2031	2016	354	297	1485
	2036	2402	421	349	1811
	2041	2488	492	401	2179

Echivalarea traficului de vehicule fizice in osii standard de 115 kN se face cu ajutorul coeficientilor de echivalare stabiliti pe tipuri de lucrari si grupe de vehicule.

Coeficientii de echivalare in osii standard de 115 kN sunt prezentati in normativul AND 584 – 2012 “ Normativ pentru determinarea traficului de calcul pentru proiectarea drumurilor din punct de vedere al capacitatii portante si al capacitatii de circulatie ”.

Coeficientii de echivalare a vehiculelor fizice in osii standard de 115 kN sunt determinati pe trei tipuri de lucrari (tabelul 3):

- Sisteme rutiere suple si semirigide noi
- Ranforsare sisteme rutiere suple si semirigide
- Sisteme rigide



Coeficientii de echivalare a vehiculelor fizice in osii de 115 kN

Tabelul 3

Tipuri de structuri rutiere	Grupe de vehicule					
	Autocamioane si derivate cu 2 osii	Autocamioane si derivate cu 3-4 osii	Autovehicule articulate	Autobuze	Tractoare cu remorci	Tren rutier
Suple si semirigide	0.1	0.7	0.9	0.6	0.1	1
Ranforsari structuri rutiere suple si semirigide	0.1	0.8	1.1	0.6	0.1	1.2
Rigide	0.2	2.6	1.5	2	0.2	1.4

Pentru dimensionarea structurii rutiere se determina traficul de calcul exprimat in osii standard de 115 kN.

Conform Normativului AND 584 – 2012, traficul de calcul pentru dimensionarea structurilor rutiere se exprima in milioane de osii standard de 115 kN (m.o.s) si se stabileste cu relatia:

$$N_c = 365 \times 10^6 \times c_{rt} \times 0.5 \times \sum_{i=1}^n (MZA_{s,i} + MZA_{s,i+1}) \times t_i \quad (1)$$

In care:

$MZA_{s,i}$ si $MZA_{s,i+1}$ = intensitatea medie zilnica anuala a traficului, exprimat in osii standard, la inceputul si sfarsitul perioadei " t_i " de prognoza;

c_{rt} = coeficient de repartitie transversala a traficului pe banda de circulatie cea mai solicitata; pentru drumuri cu 2 benzi de circulatie $c_{rt} = 0.50$.

Pentru dimensionarea structurilor rutiere rigide, la care perioada de perspectiva este $P_p = 30$ ani, in cazul in care nu se dispune de prognoza de trafic pentru intreaga perioada, traficul de calcul se determina cu relatia:

$$N_c = 365 \times 10^6 \times c_{rt} \times P_p \times MZA_s$$



In care MZA_s este intensitatea medie zilnica anuala a traficului in osii standard de 115 kN, la mijlocul perioadei de perspectiva.

Traficul MZA in osii standard de 115 kN pentru sectoarele de drum aferente Variantei de ocolire determinat prin echivalarea in osii standard a traficului de vehicule fizice prognozate pentru perioada 2021 – 2036 (tabelul 2) precum si traficul de calcul (N_c) si clasa de trafic sunt prezentate in tabelul 4.

Pentru proiectarea structurii rutiere pe Varianta de ocolire se recomanda sa se adopte traficul de calcul cel mai mare, respectiv de 4.04 m.o.s. pentru structuri rutiere suple si semirigide si de 20.30 m.o.s. pentru structuri rutiere rigide.

Traficul de calcul pentru dimensionarea structurilor rutiere noi

Tabelul 4

Structura rutiera	Sectorul de drum	Trafic MZA, osii standard 115 kN, in anul				Trafic de calcul N_{c15} M.O.S.
		2021	2026	2031	2036	
Supla si semirigida	DJ591 - DN59	261	283	346	421	0.89
	DN59 - DJ592	1106	1195	1463	1780	3.74
	DJ592 - DN6	1197	1294	1580	1916	4.04
Rigida	DJ591 - DN59	470	515	627	761	4.17*
	DN59 - DJ592	2141	2307	2806	3400	18.62*
	DJ592 - DN6	2350	2531	3071	3708	20.30*

* N_{c30}



3. Traficul de calcul pentru dimensionarea structurilor rutiere suple si semirigide pe drumurile intersectate de Varianta de ocolire

Varianta de ocolire intesecteaza doua drumuri nationale (DN6 si DN59), trei drumuri judetene (DJ 591, DJ 592 si DJ 593) si o serie de drumuri comunale si vicinale.

Determinarea traficului de calcul pentru aceste drumuri este necesara in vederea dimensionarii structurii rutiere in zona amenajarii intersectiilor acestora cu Varianta de ocolire.

Datele de trafic de baza pentru drumurile nationale si judetene intersectate de Varianta de ocolire au fost primite de la beneficiar (Anexa 1) sub forma:

- Rezultatele recensamantului de circulatie din anul 2015 pe drumurile din judetul Timis;
- Fluxurile de trafic de prognoza (2020 – 2040) in intersectiile Variantei de ocolire cu drumurile nationale si judetene, fluxuri exprimate in traficul MZA pentru 4 grupe de vehicule (autoturisme, autocamioane cu 2 osii, autocamioane cu 3 – 4 osii si vehicule articulate)

Pe baza acestor date s-au determinat prognozele de trafic pentru fiecare DN si DJ, pentru perioada 2020 – 2040, dupa care, prin interpolari, s-a determinat prognoza pentru perioada 2021 – 2036, considerand ca darea in exploatare a Variantei de ocolire va fi anul 2021.

In continuare, traficul de prognoza, pe grupe de vehicule, a fost echivalat in osii standard de 115 kN.

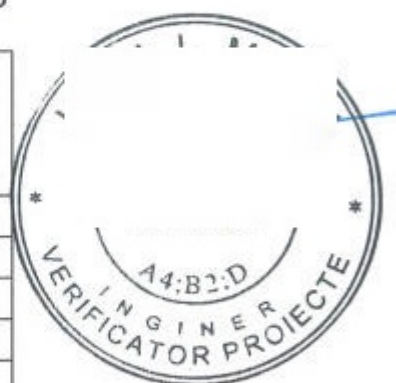
Traficul MZA, pentru fiecare drum si an de prognoza, exprimat in osii standard/zi, pentru perioada 2021 – 2036, precum si determinarea traficului de calcul pentru 15 ani, este prezentat in tabelul 5.



Traficul de calcul pentru dimensionarea structurilor rutiere suple si semirigide, pe drumurile intersectate de Varianta de ocolire

Tabelul 5

Drumul	Traficul MZA, osii standard 115 kN				Traficul de calcul N _c 15 m.o.s.
	2021	2026	2031	2036	
DN 6	998	1137	1404	1467	3.44
DN 59	858	1053	1288	1572	3.24
DJ 591	309	387	490	617	1.22
DJ 592	352	438	535	612	1.33
DJ 593	131	163	206	259	0.51



In ceea ce privesc drumurile comunale, pe Varianta de ocolire sunt prevazute trei intersectii la nivel cu DC98, DC149 si DC152.

Intrucat pe aceste drumuri comunale nu s-au facut recensaminte de circulatie si beneficiarul nu detine alte date asupra traficului de pe acestea se propune ca, pentru dimensionarea structurii rutiere la intersectia cu Varianta de ocolire, sa se adopte traficul de calcul mediu pe ansamblul de drumuri comunale.

Determinarea traficului de prognoza, mediu pe reseaua de drumuri comunale recensate, din anul 2015 s-a efectuat conform metodologiei din Normativul AND 584/2012 si este prezentata in tabelul 8.

La determinarea traficului de prognoza mediu au fost utilizate urmatoarele date si elemente de calcul:

- Traficul mediu zilnic anual, mediu pe reseaua de drumuri comunale, rezultat in urma recensamantului de circulatie din anul 2015.
- Coeficientii medii de evolutie a traficului in perioada 2015 – 2040 pentru reseaua de drumuri comunale, elaborati de INCERTRANS si avizati de CNAIR (tabelul 6).
- Pentru echivalarea traficului de vehicule fizice in vehicule etalon si osii de 115 kN au fost folosite tabelele de echivalare recomandate de normativul AND 584/2012 si anume:
 - Pentru echivalarea in osii de 115 kN tabelul 3;
 - Pentru echivalarea in vehicule etalon de tip autoturism, tabelul 7.

Coefficientii de evolutie a traficului in perioada 2015 – 2040

Coefficientii medii (varainta probabila)

Reteaua de drumuri comunale

Tabelul 6



Anul	Biciclete, motociclete	Autoturisme	Microbuze	Autocamionete	Autocamioane si derivate			Autovehicule articulate	Autobuze	Tractoare cu/fara remorca veh. Speciale	Autocamioane cu remorci (tren rutier)	Vehicule cu tractiune animala	Total vehicule
					2 osii	3-4 osii							
2015	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2020	0.73	1.35	0.81	1.03	1.04	0.73	0.85	1.23	1.23	0.65	1.03	0.72	1.15
2025	0.90	1.68	1.00	1.22	1.10	0.88	1.06	1.58	1.58	0.80	1.05	0.60	1.43
2030	1.12	2.08	1.23	1.50	1.21	1.05	1.31	1.90	1.90	0.98	1.07	0.49	1.73
2035	1.38	2.54	1.51	1.85	1.45	1.25	1.60	2.34	2.34	1.19	1.10	0.40	2.10
2040	1.69	3.11	1.85	2.32	1.74	1.48	1.96	2.87	2.87	1.45	1.25	0.32	2.56

Coeficientii pentru echivalarea vehiculelor fizice in vehicule etalon de tip autoturism pe drumurile publice

Tabelul 7

Relief	Biciclete Motociclete	Autoturisme, microbuze*, autocamionete*	Autocamioane			Vehicule articulate	Autobuze	Tractoare cu/fara remorca, veh. Speciale	Autocamioane cu remorci (tren rutier)	Vehicule cu tractiune animala
			2 osii	3-4 osii						
0	1	2	3	4	5	6	7	8	9	
Drum cu doua benzi										
Ses	0.5	1.0	2.5	2.5	3.5	2.5	3.5	4.0	3.0	
Deal	0.5	1.0 ; 1.2*	5.0	5.0	5.0	5.0	5.0	5.0	3.0	
Munte	0.5	1.0 ; 1.2*	7.2	7.2	7.2	7.2	7.2	7.2	3.0	
Drum cu patru benzi si autostrada										
Ses	0.5	1.0	1.5	1.5	1.5	1.5	1.5	1.5	3.0	
Deal	0.5	1.0 ; 1.2*	2.5	2.5	2.5	2.5	2.5	2.5	3.0	
Munte	0.5	1.0 ; 1.2*	4.5	4.5	4.5	4.5	4.5	4.5	3.0	



Determinarea traficului de prognoza mediu pentru rețeaua de drumuri comunale recensate

Tabelul 8

Anul	MZA pe categorii de vehicule													
	Biciclete, motociclete	Autoturisme	Microbuze	Autocamioane	Autocamioane si derivate		Autovehicule articulate	Autobuze	Tractoare cu/fara remorca veh. Speciale	Autocamioane cu remorci (tren rutier)	Vehicule cu tractiune animala	Total vehicule	osi 115 kN	Vehicule etalon
					2 osii	3-4 osii								
2015	65	426	29	50	22	14	7	30	23	5	38	709	44	942
2020	45	570	24	47	17	10	5	37	13	3	35	806	40	1004
2025	56	703	29	58	21	12	6	46	17	4	30	982	49	1202
2030	71	873	36	73	26	15	8	57	21	5	24	1209	62	1456
2035	89	1082	44	91	32	18	11	71	27	5	18	1488	76	1736
2040	110	1325	54	112	38	21	14	86	33	6	12	1811	77	2133



Determinarea traficului de calcul pentru rețeaua de drumuri comunale, pentru perioada de prognoza de 15 ani (2021 – 2036) este prezentat in tabelul 9.

Traficul de calcul mediu pe rețeaua de drumuri comunale

Tabelul 9

Anul	2021	2026	2031	2036
MZA osii 155 kN	42	51	65	76
Traficul de calcul Nc15	0.16 m.o.s.			



4. Concluzii

Analizele efectuate in cadrul studiului de trafic au condus la realizarea urmatoarelor obiective:

- 1) Determinarea traficului de calcul pentru dimensionarea structurilor rutiere pe Varianta de ocolire Timisoara – Sud

Traficul de calcul s-a determinat separat pe cele trei sectoare ale Variantei de ocolire Timisoara – Sud, pe o durata de perspectiva de 15 ani pentru structurile rutiere suple si semirigide si de 30 de ani pentru structurile rutiere rigide.

Pentru proiectarea structurii rutiere se recomanda adoptarea traficului de calcul cel mai mare, respectiv de pe sectorul DJ592 – DN6, unde valorile de trafic au rezultat:

$N_c = 4.04$ m.o.s. pentru structuri suple si semirigide

$N_c = 20.30$ m.o.s. pentru structurile rutiere rigide.

Valorile $N_c = 20.30$ m.o.s. pentru structuri rutiere rigide se pot aplica si pentru dimensionarea platformelor de parcare din lungul drumului.

- 2) Determinarea traficului de calcul pentru dimensionarea structurilor rutiere pe drumurile intersectate de Varianta de ocolire.

Varianta de ocolire Timisoara – Sud intersecteaza doua drumuri national, trei drumuri judetene si trei drumuri comunale.

Traficul de calcul determinat pentru aceste drumuri publice intersectate este prezentat in tabelul de mai jos.

Drumul	DN6	DN59	DJ591	DJ592	DJ593	Drumurile comunale
Traficul de calcul Nc15 perioada 2021 - 2036	3.44 m.o.s.	3.24 m.o.s.	1.22 m.o.s.	1.33 m.o.s.	0.51 m.o.s.	0.16 m.o.s.

Prin realizarea obiectivelor de mai sus, studiul de trafic determina principalele elemente de trafic necesare dimensionarii structurilor rutiere de pe Varianta de ocolire Timisoara – Sud.



5. Bibliografie

- 1) Varianta de ocolire Timisoara – Sud. Studiu de trafic, Search Corporation si Technic Consulting, 2011
- 2) Varianta ocolitoare Timisoara – Sud. Revizuire studiu de trafic. CESTRIN 2017
- 3) Proiectare si executie “Varianta de ocolire a Municipiului Timisoara Sud”, Cerintele beneficiarului CNAIR, 2017
- 4) AND 584/2012 – Normativ pentru determinarea traficului de calcul pentru proiectarea drumurilor din punct de vedere al capacitatii portante si a capacitatii de circulatie. Buletin Tehnic Rutier nr 12/2012
- 5) Instructiuni tehnice privind determinarea starii tehnice a drumurilor moderne. Indicativ CD 155 – 2001, Buletin Tehnic Rutier nr 2/2001
- 6) Elaborarea coeficientilor de evolutie si a ratelor medii de crestere pentru perioada 2015 – 2040. Raport final, INCERTRANS S.A. 2016
- 7) Traficul mediu zilnic anual pe total retele de drumuri_2015, CESTRIN, 2016



Anexa 1

Date de trafic furnizate de beneficiar



Varianta de ocolire Timisoara Sud

Studiu de trafic – 2

Determinarea capacitatii de circulatie a intersectiilor rutiere de tip giratoriu



Determinarea capacitatii de circulatie a intersectiilor viitoare de pe Varianta de ocolire Timisoara Sud

1. Obiective

Pe Varianta de ocolire Timisoara Sud este prevazuta realizarea a opt intersectii care asigura legatura Variantei de colire cu reseaua rutiera existenta (tabelul 1).

Intersectii pe Varianta de ocolire Timisoara Sud (VOTS)

Tabelul 1

Nr	Pozitia km pe varianta ocolitoare	Drum intersectat	Tip intersectie
1	0 + 290	Intersectie cu strada P. Morand	Intersectie la nivel tip giratie
2	5 + 366	DJ 593, DN 59	Nod rutier
3	11 + 576	Drum acces Giroc	Pasaj supratran si giratii
4	14 + 608	DJ 595D (fost DJ 152)	Intersectie la nivel tip giratie
5	16 + 510	DC 98	Intersectie la nivel tip "cruce"
6	18 + 117	DJ 592	Nod rutier
7	23 + 004	DC 149	Intersectie la nivel tip giratie
8	25 + 690	DN 6	Nod rutier

Obiectul Prezentei studiu de trafic este analiza de capacitate de circulatie a intersectiilor, cu determinarea intarzierilor de control si a nivelului de serviciu pentru fiecare.

Datele de trafic pentru analiza de capacitate de circulatie au fost furnizate de beneficiar, in baza revizuirii in anul 2017, de catre CNAIR – CESTRIN, a studiului de trafic pentru Varianta de ocolire Timisoara Sud. Au fost furnizate schemele cu fluxurile de trafic in 5 intersectii, considerate semnificative (1,2,3,6 si 8), pe grupe de vehicule si ani de prognoza, pentru perioada de 2020 – 2040. Fluxurile de trafic au fost exprimate in trafic mediu zilnic anual (MZA) pe 3 grupe de vehicule: autoturisme, vehicule de transport marfa cu 2 osii, 3 – 4 osii si vehicule articulate.

Metodologia de analiza a capacitatii de circulatie si stabilirea nivelului de serviciu pentru intersectiile rutiere a fost adoptata conform prescriptiilor in vigoare in tara noastra, respectiv:

- Normativ pentru determinarea traficului de calcul pentru proiectarea drumurilor din punct de vedere al capacitatii de circulatie – AND 584/2012
- Normativ pentru amenajarea intersectiilor la nivel pe drumurile publice – AND 600/2010
- Normativ pentru determinarea capacitatii de circulatie si a nivelului de serviciu ale drumurilor publice – Indicativ 189/2012.

Breviarul detaliat de determinarea capacitatii de circulatie si a nivelului de serviciu in intersectiile giratorii este prezentat in anexa 1.1.

2. Sinteza rezultatelor

Rezultatele obtinute in urma analizei privind capacitatea de circulatie si nivelul de serviciu pentru intersectiile rutiere care urmeaza a fi amenajate pe Varianta de ocolire Timisoara Sud sunt prezentate in breviarele din anexa1 si sintetizate in tabelul 2. Conform prescriptiilor in vigoare in tara noastra (AND 600/2010) se recomanda ca, intersectiile noi proiectate, sa functioneze pentru toate perioadele de analiza la nivelul de serviciu minim "C".

Nivelul de serviciu prognozat pentru noduri si intersectiile giratorii

Tabelul 2

Drumul intersectat de varianta de ocolire	Nivelul de serviciu prognozat pentru 2040
Strada Paul Morand	B
DN59 si DJ593	A
Din acces Giroc	B
DJ592	A
DN6	B

Mentionam ca intersectiile cu drumuri comunale nu au fost analizate, debitele de calcul pe aceste drumuri fiind reduse, fluxurile de trafic pentru aceste intersectii nefind transmise de catre beneficiar.

3. Concluzii

Din analiza efectuată, privind capacitatea de circulație și a nivelului de serviciu la intersecțiilor care urmează să fie realizate pe Varianta de ocolire Timisoara Sud, rezultă că, soluțiile de proiectare adoptate pentru acestea, asigură desfășurarea circulației în condiții foarte bune, nivelul de serviciu menținându-se în limitele recomandate (A – C) pe toată perioada de prognoză analizată (2020 – 2040). Prin realizarea acestor noduri se asigură legătura viitoare Variante de ocolire cu rețeaua de drumuri existente din zona traversată de aceasta.

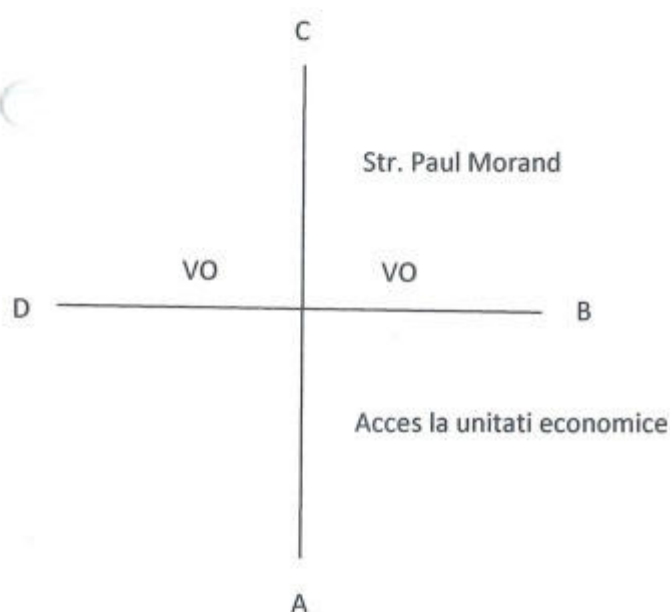
Anexa 1

**Capacitatea de circulatie a intersectiilor de pe Varianta
de ocolire Timisoara Sud**

Intersectia giratorie: Varianta de ocolire – str. Paul Morand
Brevier de calcul detaliat
Anul 2040

Anexa 1.1

1. Schema intersectiei



2. Debite orare de calcul in intersectie

Ramura	A	B	C	D	Total Q_b
A	0	190	83	0	273
B	190	0	400	62	652
C	83	400	0	0	483
D	0	62	0	0	62
Total Q_e	273	652	483	62	1470

Matricea debitelor orare in intersectie s-a determinat pe baza datelor furnizate de beneficiar si considerand ca la nivelul anului 2040 traficul pe str. Paul Morand va ajunge la capacitatea strazii

3. Seterminarea capacitatii de circulatie cu metoda de baza (AND 600/2010)

3.1 Determinarea debitului conflictual

$$V_A = Q_i^{DB} + Q_i^{DC} + Q_i^{CB} = 62 + 400 = 462$$

$$V_B = Q_i^{AC} + Q_i^{AD} + Q_i^{DC} = 83$$

$$V_C = Q_i^{AD} + Q_i^{BD} + Q_i^{CA} = 62 + 83 = 145$$

$$V_D = Q_i^{CA} + Q_i^{CB} + Q_i^{BA} = 83 + 400 + 190 = 673$$

3.2 Parametrii de calcul

- Timp critic de acces: $t_c = 4,4 \text{ sec}$
- Timp de urmare: $t_f = 2,8 \text{ sec}$
- Constanta e: $e = 3,718282$
- Perioada de analiza: $T = 0,25 \text{ ore}$

3.3 Determinarea capacitatii de circulatie pe ramuri, pentru calea inelara cu o banda

$$C_i = V_i \frac{e^{-\frac{V_i t_c}{3600}}}{1 - e^{-\frac{V_i t_f}{3600}}}$$

Rezulta:

$$C_A = 870 \text{ Vt/ora}$$

$$C_B = 1200 \text{ Vt/ora}$$

$$C_C = 1139 \text{ Vt/ora}$$

$$C_D = 725 \text{ Vt/ora}$$

3.4 Determinarea intarzierilor pe ramuri

$$d_i = \frac{3600}{C_i} + 900T \left[\frac{Q_i}{C_i} - 1 + \sqrt{\left(\frac{Q_i}{C_i} - 1 \right)^2 + \frac{3600}{C_i} \cdot \frac{Q_i}{C_i}} \right] + 5$$

Rezulta:

$$d_A = 12.15 \text{ sec}$$

$$d_B = 9.92 \text{ sec}$$

$$d_C = 10.47 \text{ sec}$$

$$d_D = 10.43 \text{ sec}$$

3.5 Agregarea intarzierilor pe intersectie

$$d_M = \frac{d_A Q_A + d_B Q_B + d_C Q_C + d_D Q_D}{Q_A + Q_B + Q_C + Q_D} = 10.54 \text{ sec}$$

3.6 Determinarea nivelului de serviciu

Determinarea nivelului de serviciu se face conform tabelului urmator

Determinarea nivelului de serviciu

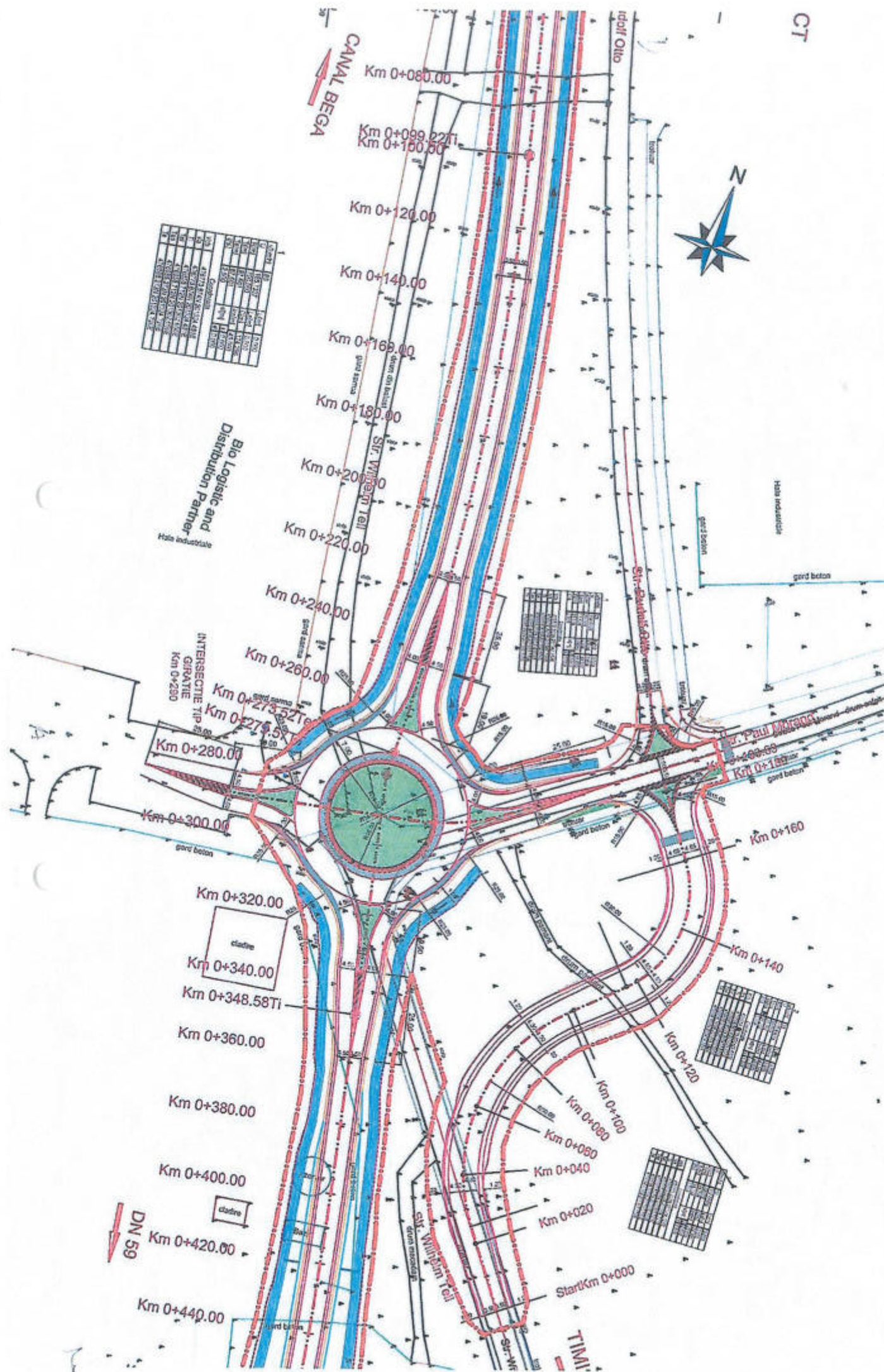
Nivelul de serviciu	Intarzierea de control sec/veh
A	<10
B	10 – 15
C	15 – 25
D	25 – 35
E	35 – 50
F	>50

Pentru $d_m = 10.54$ sec rezulta nivelul de serviciu A

3.7 Sinteza rezultatelor este prezentata in tabelul urmator

Sinteza rezultatelor

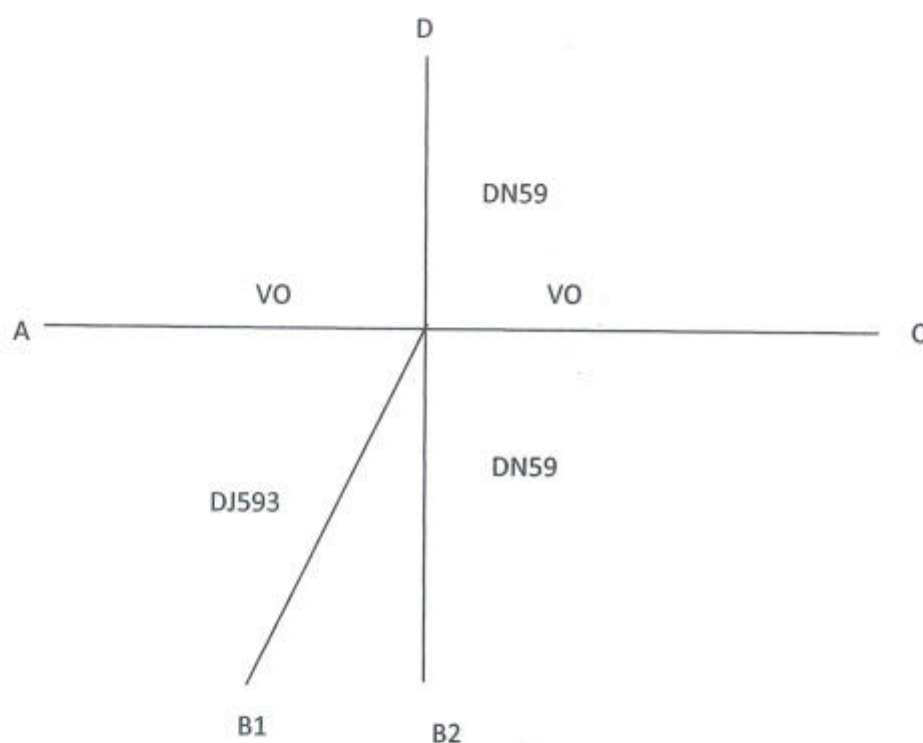
Date generale				Metoda de baza AND 600/2010							
Ramura	Flux intrare	Debit trafic Qi/ora	Debit trafic conflictual Vi	Capacitate ramura Ci	Intarziere di	Intarziere medie dm	Nivel serviciu				
A	B	190	462	870	12.15	10.54	B				
	C	83									
	D	0									
B	A	190	83	1200	9.92			10.54	B		
	C	400									
	D	62									
C	A	83	145	1139	10.47					10.54	B
	B	400									
	D	0									
D	A	0	673	725	10.43	10.54	B				
	B	82									
	C	0									



Nod rutier: Varianta de ocolire – DN59 si DJ593
Breviar de calcul detaliat
Anul 2040

Anexa 1.2

1.Schema nodului rutier



2. Debite orare de calcul in intersectie

Ramura	A	B1	B2	C	D	Total Q_i
A	0	0	413	0	23	436
B1	73	0	0	26	84	183
B2	402	0	0	0	464	866
C	0	26	145	0	0	171
D	0	84	464	162	0	710
Total Q_e	475	110	1022	188	571	2366

3. Determinarea capacitatii de circulatie cu metode de baza (AND 600/2010)

3.1 Determinarea debitului conflictual

$$V_A = Q_{iDB1} + Q_{iDB2} + Q_{iDC} + Q_{iCB1} + Q_{iCB2} = 84 + 464 + 162 + 26 + 145 = 881$$

$$V_{B1} = Q_{iAC} + Q_{iAD} + Q_{iDC} + Q_{iAB2} + Q_{iCB2} + Q_{iDB2} = 23 + 162 + 413 + 145 + 464 = 1207$$

$$V_{B2} = Q_{iAC} + Q_{iAD} + Q_{iB1C} + Q_{iB1D} + Q_{iB1A} + Q_{iDC} = 23 + 26 + 84 + 73 + 162 = 368$$

$$V_C = Q_{iAD} + Q_{iB1D} + Q_{iB2D} + Q_{iCA} + Q_{iB1A} + Q_{iB2A} = 23 + 84 + 464 + 73 + 402 = 1046$$

$$V_D = Q_{iCA} + Q_{iCB1} + Q_{iB1A} + Q_{iB2A} + Q_{iB2B1} = 26 + 73 + 402 = 501$$

3.2 Parametrii de calcul

- Timp critic de acces: $t_c = 4.4 \text{ sec}$
- Timp de urmare: $t_f = 2.8 \text{ sec}$
- Constanta e: $e = 2.718282$
- Perioada de analiza: $T = 0.25 \text{ ore}$
- Parametru pentru 2 benzi: $n_c = 1.14$

3.3 Determinarea capacitatii de circulatie pe ramuri, pentru calea inelara cu 2 benzi

$$C_i = 3600 \cdot \frac{n_c}{t_f} \cdot e^{\frac{V_i}{3600} \left(t_c - \frac{t_f}{2} \right)}$$

Rezulta:

$$C_A = 3054 \text{ Vi/ora}$$

$$C_{B1} = 4011 \text{ Vi/ora}$$

$$C_{B2} = 1992 \text{ Vi/ora}$$

$$C_C = 3504 \text{ Vi/ora}$$

$$C_D = 2225 \text{ Vi/ora}$$

3.4 Determinarea intarzierilor pe ramuri

$$d_i = \frac{3600}{c_i} + 900T \left[\frac{Q_i}{c_i} - 1 + \sqrt{\left(\frac{Q_i}{c_i} - 1 \right)^2 + \frac{\frac{3600}{c_i} \cdot \frac{Q_i}{c_i}}{450T}} \right] + 5$$

Rezulta:

$$d_A = 8.38 \text{ sec}$$

$$d_{B1} = 5.93 \text{ sec}$$

$$d_{B2} = 8.18 \text{ sec}$$

$$d_C = 11.88 \text{ sec}$$

$$d_D = 7.37 \text{ sec}$$

3.5 Agregarea intarzierilor pe intersectie

$$d_M = \frac{d_A Q_A + d_{B1} Q_{B1} + d_{B2} Q_{B2} + d_C Q_C + d_D Q_D}{Q_A + Q_{B1} + Q_{B2} + Q_C + Q_D} = 8.07 \text{ sec}$$

3.6 Determinarea nivelului de serviciu

Determinarea nivelului de serviciu se face conform tabelului urmator

Determinarea nivelului de serviciu

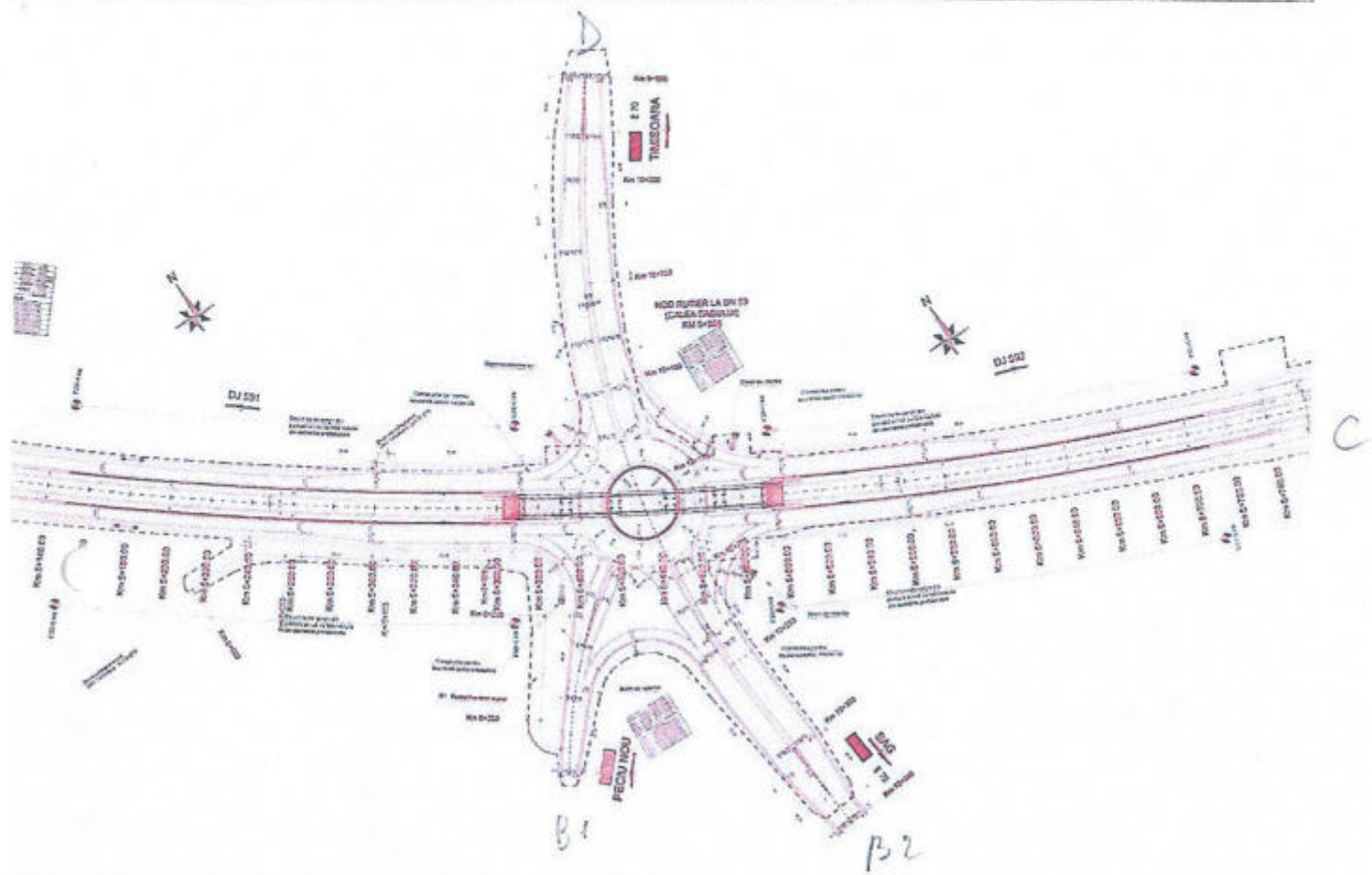
Nivelul de serviciu	Intarzieri de control sec/veh
A	<10
B	10 – 15
C	15 – 25
D	25 – 35
E	35 – 50
F	>50

Rezulta nivelul de serviciu A

3.7 Sinteza rezultatelor este prezentata in tabelul urmator

Sinteza rezultatelor

Date generale				Metoda de baza AND 600/2010			
Ramura	Flux intrari	Debit trafic Q/ora	Debit trafic conflictual V_i	Capacitati ramuri C_i	Intarzieri d_i	Intarziere medie d_m	Nivel de serviciu
A	B1	0	881	3054	8.38	8.07	A
	B2	0					
	C	0					
	D	23					
B1	B2	0	1208	4011	5.93		
	C	26					
	D	84					
	A	73					
B2	C	0	368	1992	8.18		
	D	464					
	A	402					
	B1	0					
C	D	0	1046	3504	11.88		
	A	0					
	B1	26					
	B2	145					
D	A	0	501	2225	7.35		
	B1	84					
	B2	464					
	C	162					



Fluxuri de trafic in intersectii
Anul 2040

DN59

Tur 0
Tur 4620
Tur 0
Tur 4620
Tur 0

Tur 0
Tur 760
Tur 4640

Tur 0
Tur 760
Tur 4640

Tur 0
Tur 760
Tur 1489

Tur 0
Tur 760
Tur 1489

Tur 1489
Tur 4620
Tur 4640
Tur 1489
Tur 4620
Tur 4640

DN59

DN59

2 osii 0
2 osii 172
2 osii 84
2 osii 0
2 osii 172
2 osii 84

2 osii 84
2 osii 0
2 osii 0
2 osii 84
2 osii 0
2 osii 0

2 osii 0
2 osii 0
2 osii 94
2 osii 0
2 osii 0
2 osii 94

2 osii 94
2 osii 172
2 osii 0
2 osii 94
2 osii 172
2 osii 0

DN59

DN59

3/4 osli 153
3/4 osli 39
3/4 osli 0
3/4 osli 153
3/4 osli 39
3/4 osli 0

3/4 osli 0
3/4 osli 0
3/4 osli 21
3/4 osli 0
3/4 osli 0
3/4 osli 21

3/4 osli 153
3/4 osli 0
3/4 osli 13

3/4 osli 153
3/4 osli 0
3/4 osli 13

3/4 osli 13
3/4 osli 39
3/4 osli 21
3/4 osli 13
3/4 osli 39
3/4 osli 21

DN59

DN59

art 926
art 364
art 152

art 926
art 364
art 152

art 152
art 39
art 54

art 152
art 39
art 54

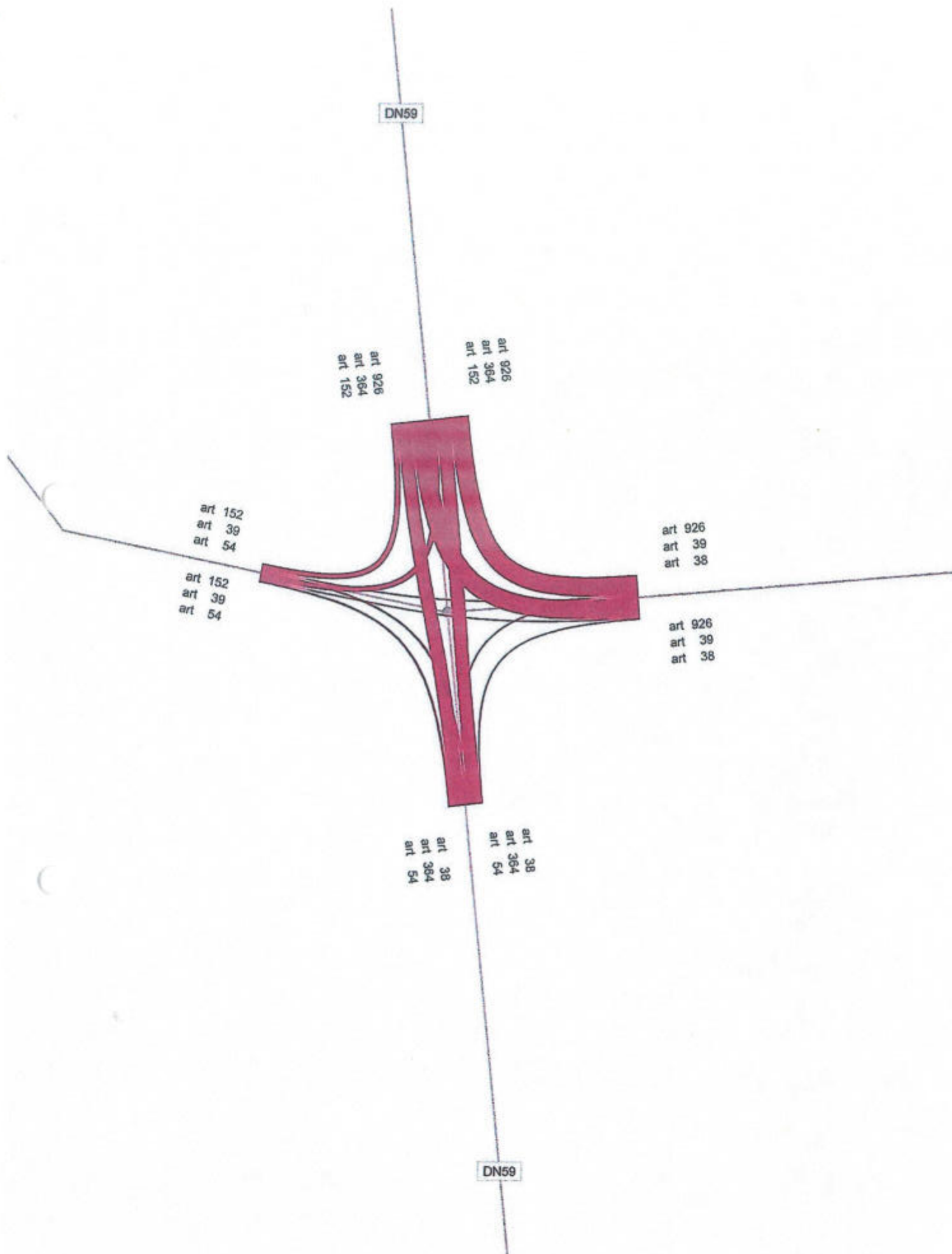
art 926
art 39
art 38

art 926
art 39
art 38

art 38
art 364
art 54

art 38
art 364
art 54

DN59



Repartizarea traficului in intersectie pentru ramura B

Ramura intersectiei	MZA vehicule pe grupe in 2040				Raport total vehicule DJ593/DN59	
	Autoturisme Autocamionete	Vehicule de marfa cu 2 osii	3 – 4 osii	Vehicule articulate	V _{fizice}	V _{etalon}
DN59	23930	281	133	1378	0.176	0.183
DJ593	4085	67	15	356		
DJ593/DN59	0.171	0.238	0.113	0.256		
DJ593/(DN59 + DJ 593)	0.146	0.193	0.101	0.204	0.149	0.154

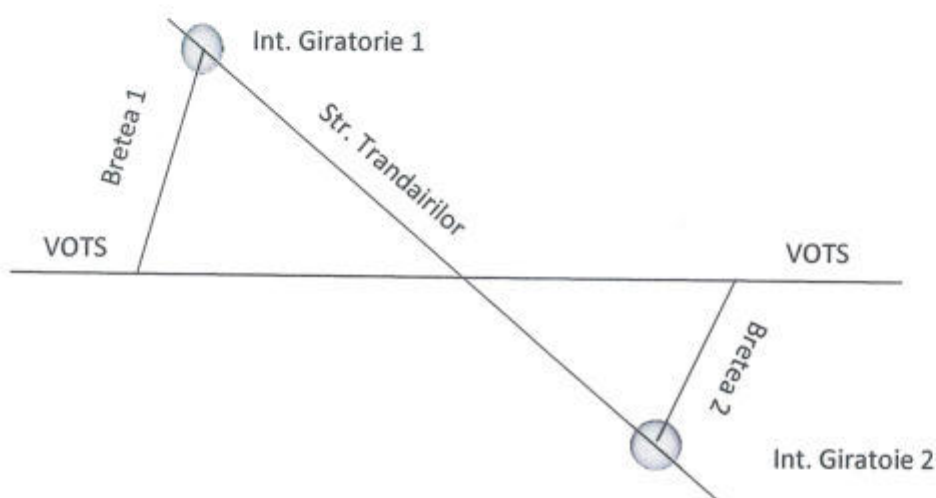
Intersectia intre VOTS si str. Trandafirilor

Breviar de calcul

Anul 2040

Anexa 1.3

1. Schema intersectiei



2. Debite orare de calcul in intersectie

Intersectia intre varianta de ocolire si str. Trandafirilor este complexa incluzand 4 intersectii simple:

- 2 giratii(giratia 1, giratia 2)
- 2 intersectii intre bretelele 1 si 2 cu Varianta de ocolire

La nivelul anului de prognoza 2040 verificarea capacitatii de circulatie a intersectiei se face considerand ca pe strada Trandafirilor traficul a ajuns la nivelul capacitatii de circulatie a unei strazi de categoria III, respectiv la 1200 de vehicule etalon/ora, iar pe varianta de ocolire traficul va fi cel prognozat si comunicat de beneficiar (CNAIR – CESTRIN).

Pentru intersectia giratorie 1, considerand ca cea mai solicitata, distributia fluxurilor de trafic de calcul de prognoza (2040), este prognozata in matricea din tablul 1.

Debitele orare de calcul in intersectis giratorii 1

Tabelul 1

Ramura intersectie	Bretea 1	B	D	Total Q _e
Bretea 1	0	0	400	400
B	400	0	400	800
D	0	400	0	400
Total Q _i	400	400	800	1600

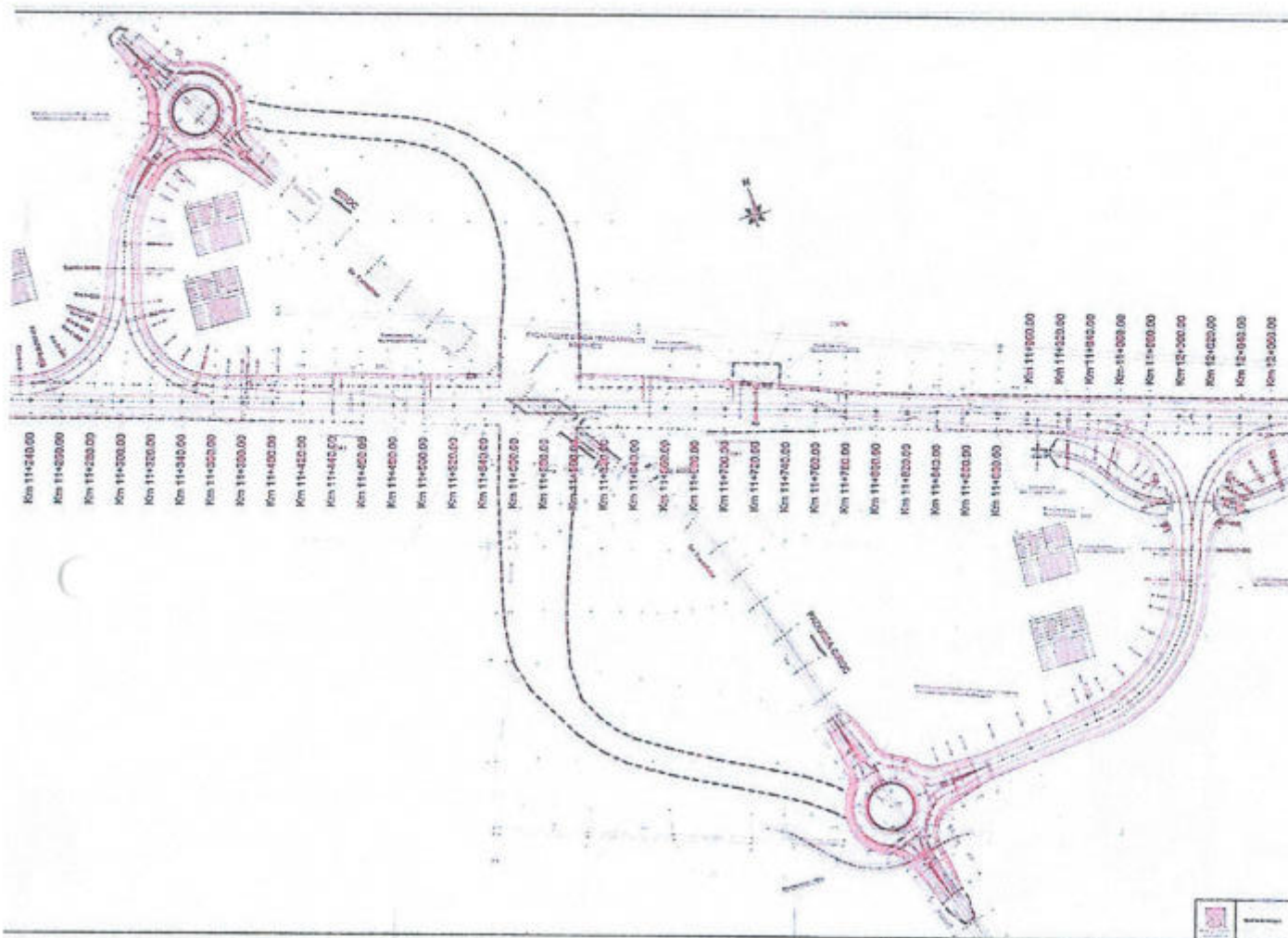
S-a considerat ca pe strada Trandafirilor traficul pe sensul cel mai incarcat este de $\frac{2}{3}$ din traficul pe ambele sensuri, respectiv din 800 de vehicule etalon/ora

Determinarea capacitatii de circulatie sa facut cu metoda de baza din normativul AND 600/2010, sinteza rezultatelor fiind prezentata in tabelul 2.

Sinteza rezultatelor

Tabelul 2

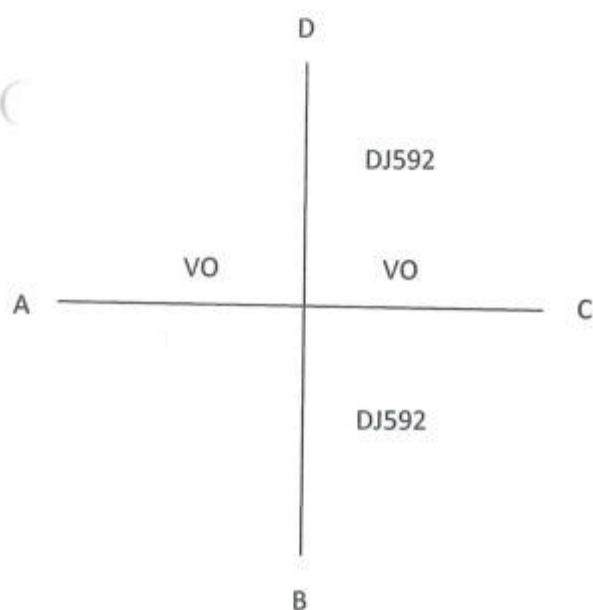
Date generale				Metoda de baza AND 600/2010			
Ramura Intersectie	Flux intrare	Debit trafic Qi/ora	Debit trafic conflictual Vi	Capacitate ramura Ci	Intarziere di	Intarziere medie dm	Nivel serviciu
Bretea 1	B	0	400	918	11.91	7.17	A
	D	400					
B	Bretea 1	400	400	918	11.91		
	D	400					
D	Bretea 1	0	400	918	11.91		
	B	400					



Intersectia giratorie: Varianta de ocolire – DJ592 **Breviar de calcul detaliat** **Anul 2040**

Anexa 1.4

1. Schema intersectiei



2. Debite orare de calcul in intersectie

Vehicule etalon/ora in anul 2040

Ramura	A	B	C	D	Total Q_i
A	0	218	423	0	641
B	218	0	190	190	598
C	423	190	0	0	613
D	0	190	0	0	190
Total Q_e	641	598	613	190	2042

3. Determinarea capacitatii de circulatie cu metoda de baza (AND 600/2010)

3.1 Determinarea debitului conflictual

$$V_A = Q_i^{DB} + Q_i^{DC} + Q_i^{CB} = 190 + 190 = 380$$

$$V_B = Q_i^{AC} + Q_i^{AD} + Q_i^{DC} = 423$$

$$V_C = Q_i^{AD} + Q_i^{BD} + Q_i^{CA} = 190 + 423 = 613$$

$$V_D = Q_i^{CA} + Q_i^{CB} + Q_i^{BA} = 423 + 190 + 218 = 831$$

3.2 Parametrii de calcul

- Timp critic de acces: $t_c = 4,4 \text{ sec}$
- Timp de urmare: $t_f = 2,8 \text{ sec}$
- Constanta e: $e = 3,718282$
- Perioada de analiza: $T = 0,25 \text{ ore}$
- Parametru pentru 2 benzi: $n_c = 1,14$

3.3 Determinarea capacitatii de circulatie pe ramuri, pentru calea inelara cu 2 benzi

$$C_i = 3600 \cdot \frac{n_c}{t_f} \cdot e^{\frac{V_i}{3600}(t_c - \frac{t_f}{2})}$$

Rezulta:

$$C_A = 2012 \text{ Vt/ora}$$

$$C_B = 2086 \text{ Vt/ora}$$

$$C_C = 2443 \text{ Vt/ora}$$

$$C_D = 2930 \text{ Vt/ora}$$

3.4 Determinarea intarzierilor pe ramuri

$$d_i = \frac{3600}{C_i} + 900T \left[\frac{Q_i}{C_i} - 1 + \sqrt{\left(\frac{Q_i}{C_i} - 1 \right)^2 + \frac{3600 \cdot \frac{Q_i}{C_i}}{C_i}} \right] + 5$$

Rezulta:

$$d_A = 7,40 \text{ sec}$$

$$d_B = 7,42 \text{ sec}$$

$$d_C = 6,96 \text{ sec}$$

$$d_D = 6,31 \text{ sec}$$

3.5 Agregarea intarzierilor pe intersectie

$$d_M = \frac{d_A Q_A + d_B Q_B + d_C Q_C + d_D Q_D}{Q_A + Q_B + Q_C + Q_D} = 7,17 \text{ sec}$$

3.6 Determinarea nivelului de serviciu

Determinarea nivelului de serviciu se face conform tabelului urmator

Determinarea nivelului de serviciu

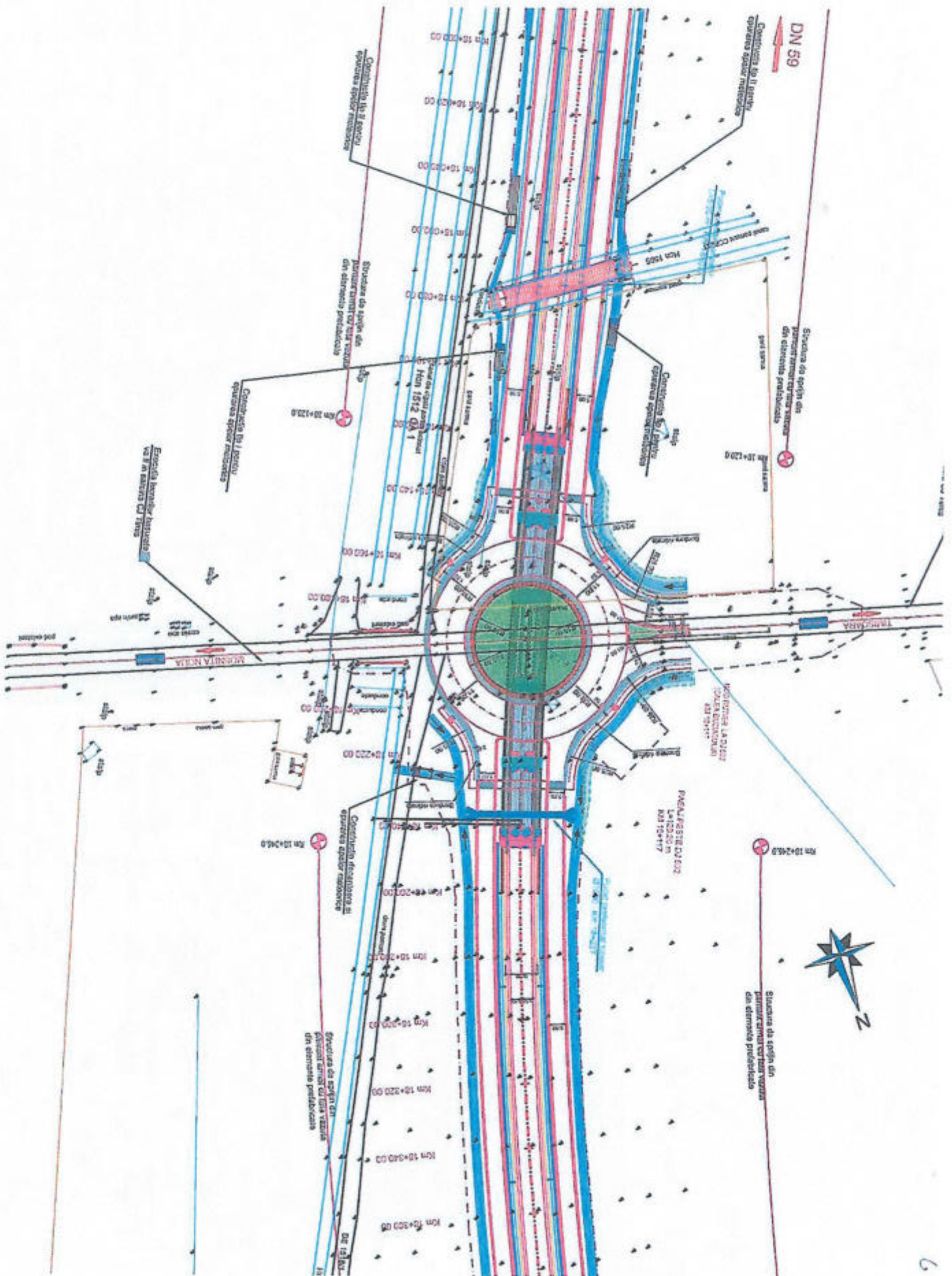
Nivelul de serviciu	Intarzierea de control sec/veh
A	<10
B	10 – 15
C	15 – 25
D	25 – 35
E	35 – 50
F	>50

Pentru $d_m = 7,17$ sec rezulta nivelul de serviciu A

3.7 Sinteza rezultatelor este prezentata in tabelul urmator

Sinteza rezultatelor

Date generale				Metoda de baza AND 600/2010							
Ramura	Flux intrare	Debit trafic Qi/ora	Debit trafic conflictual Vi	Capacitate ramura Ci	Intarziere di	Intarziere medie dm	Nivel serviciu				
A	B	218	380	2012	7.40	7.17	A				
	C	423									
	D	0									
B	A	218	423	2086	7.42			7.17	A		
	C	190									
	D	190									
C	A	423	613	2443	6.96					7.17	A
	B	190									
	D	0									
D	A	0	831	2930	6.31	7.17	A				
	B	190									
	C	0									



Fluxul de trafic in intersectie

Anul 2040



Tur 0
Tur 402
Tur 1847
Tur 0
Tur 402
Tur 1847

Tur 0
Tur 1898
Tur 0
Tur 1898
Tur 0

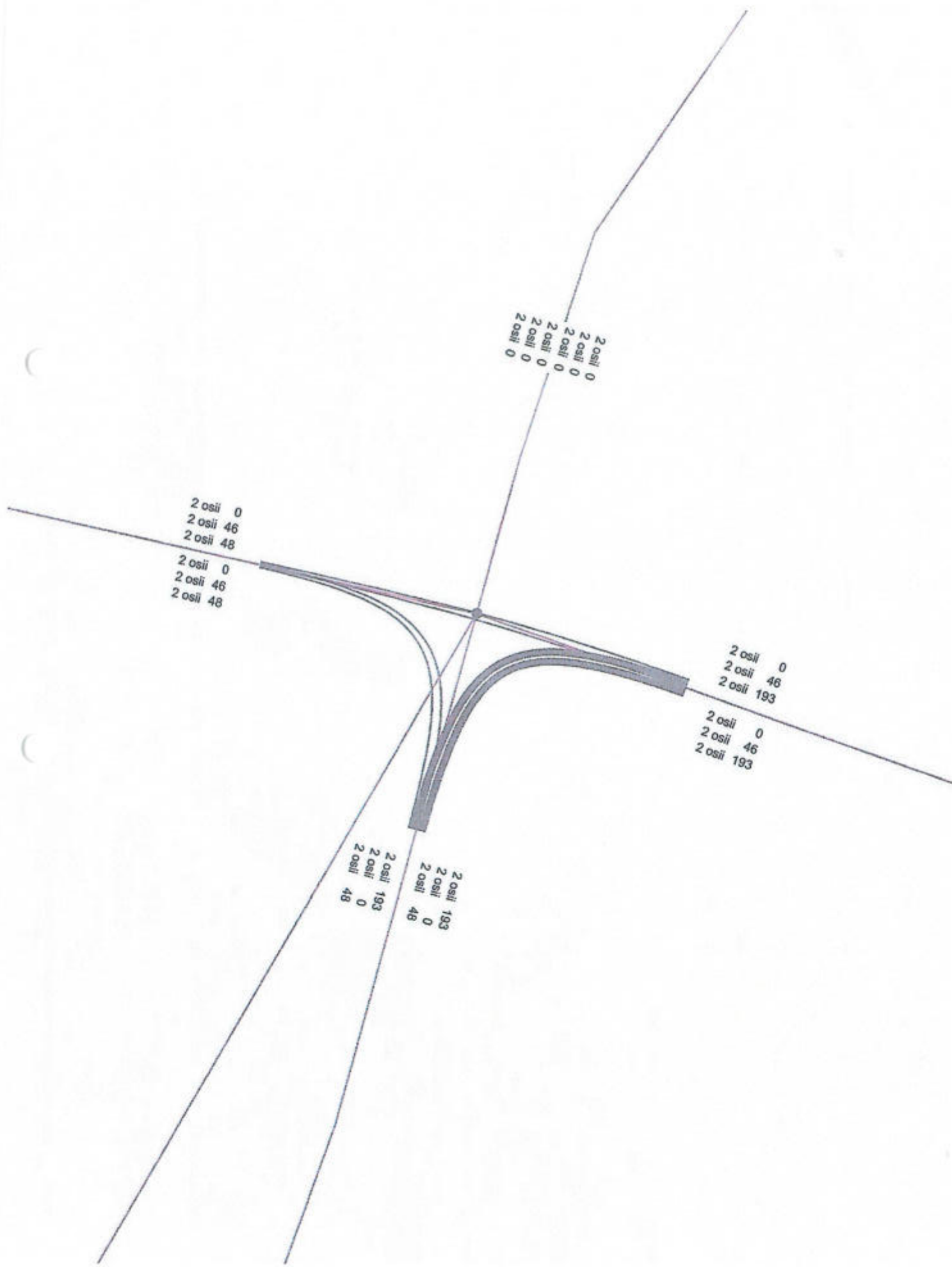
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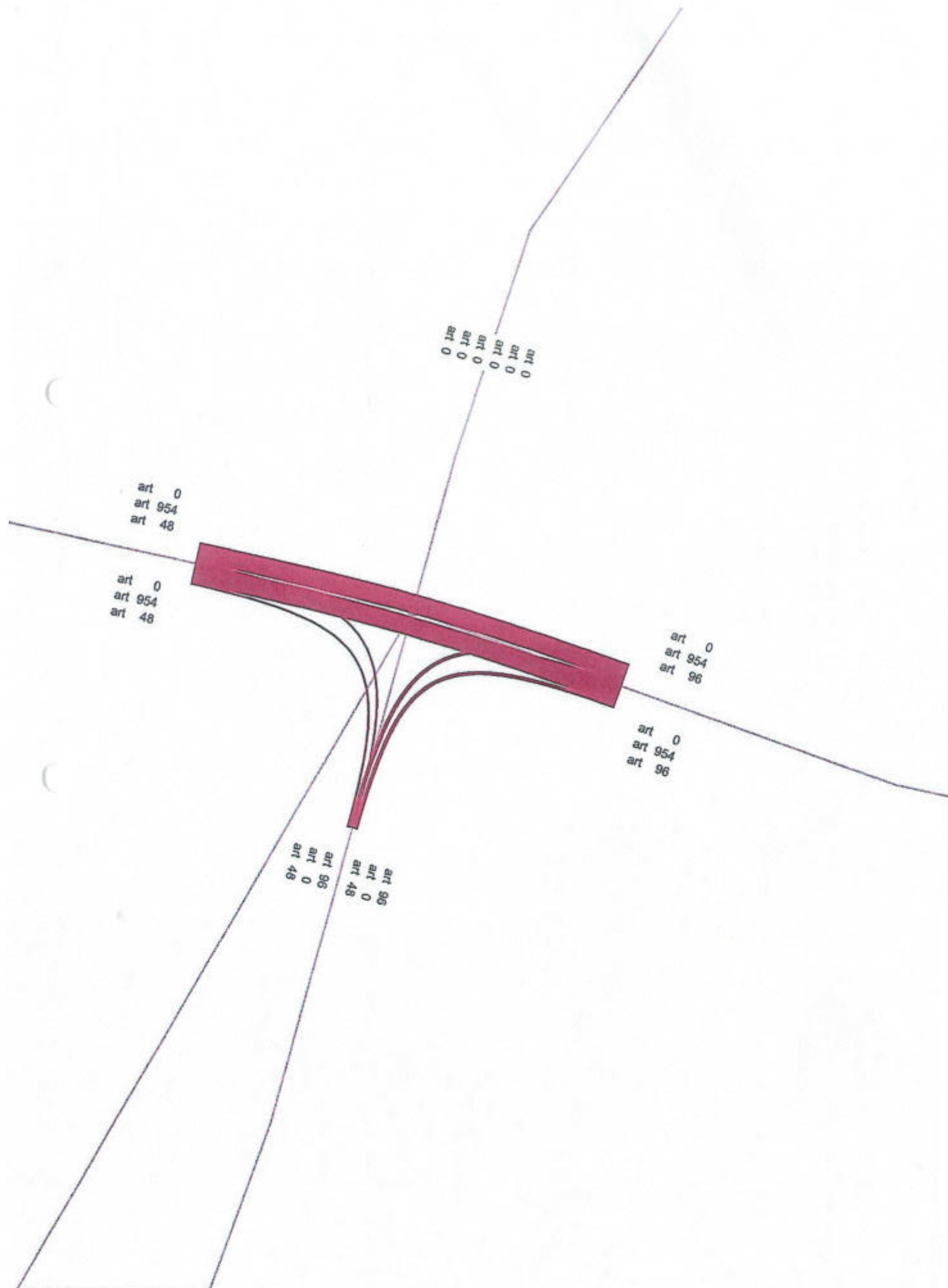


3/4 osii 0
3/4 osii 0
3/4 osii 0
3/4 osii 0
3/4 osii 0
3/4 osii 0

3/4 osii 0
3/4 osii 148
3/4 osii 18
3/4 osii 0
3/4 osii 148
3/4 osii 18

3/4 osii 0
3/4 osii 148
3/4 osii 47
3/4 osii 0
3/4 osii 148
3/4 osii 47

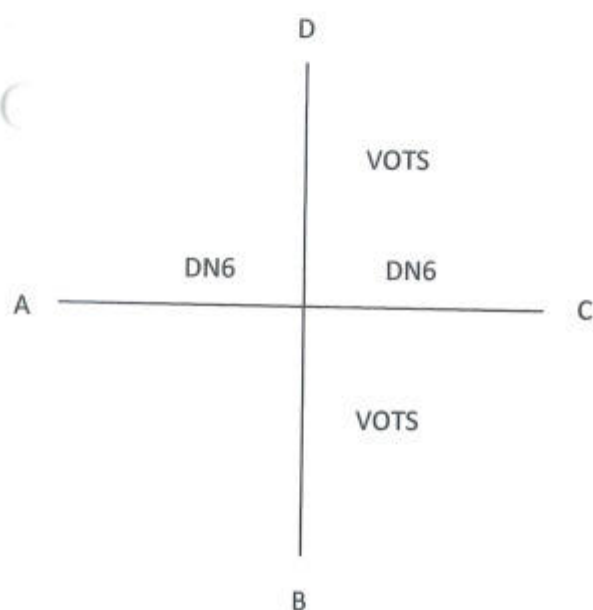
3/4 osii 47
3/4 osii 0
3/4 osii 18
3/4 osii 47
3/4 osii 0
3/4 osii 18



Nod rutier: Varianta de ocolire – DN6
Breviar de calcul
Anul 2040

Anexa 1.5

1. Schema intersectiei



2. Debite orare de calcul in intersectie

Ramura	A	B	C	D	Total Q_i
A	0	0	635	0	635
B	0	0	296	317	613
C	635	296	0	474	1405
D	0	317	477	0	794
Total Q_e	635	613	1408	791	3447

3. Determinarea capacitatii de circulatie cu metoda de baza (AND 600/2010)

Pentru determinarea capacitatii de circulatie si a nivelului de serviciu, fluxurile de trafic de prognoza pentru anul 2040 au fost transformate din trafic $MZA_E(V_t/24 \text{ ore})$ in trafic orar de calcul(V_t/ora) prin aplicarea coeficientului $k = 0.10$, reprezentand raportul intre debitul corespunzator celei de-a 50-a ora de varf si MZA_E .

Metodologia de calcul pentru determinarea capacitatii de circulatie a nodului care este proiectat ca o intersectie la nivel, a fost adoptata conform metodologiei de calcul pentru intersectii la nivel, nesemaforizate, recomandata in normativul AND 600 – 2010, capitolul 5.

3.1 Parametrii de calcul

- Timp critic de acces:
 - 2 benzi pe artera principala $t_a = 6.2 \text{ sec}$
 - 4 benzi pe artera principala $t_a = 6.9 \text{ sec}$
- Timp de urmare: $t_n = 3,3 \text{ sec}$
- Constanta e: $e = 2,718282$
- Perioada de analiza: $T = 0,25 \text{ ore}$

3.2 Relatiile de calcul de baza

- Capacitatea aferenta fiecarui flux(miscare) C_x

$$C_x = V_x \frac{e^{-\frac{V_x t_a}{3600}}}{1 - e^{-\frac{V_x t_n}{3600}}}$$

unde:

- V_x este volumul de conflict aferent miscarii x
- t_a este timpul critic de acces aferent miscarii x
- t_n este timpul de urmare aferent miscarii x

- Determinarea intarzierilor de control(sec/veh)

$$d_x = \frac{3600}{C_x} + 900T \left[\frac{V_x}{C_x} - 1 + \sqrt{\left(\frac{V_x}{C_x} - 1 \right)^2 + \frac{\frac{3600}{C_x} \cdot \frac{V_x}{C_x}}{450T}} \right] + 5$$

unde:

- d_x este valoarea intarzierii de control(sec/veh)
- T este perioada de analiza, recomandata 15 minute: $T = 0.25 \text{ ore}$

- Agregarea intarzierilor pe intersectie:

$$d_i = \frac{\sum d_x Q_x}{\sum Q_x}$$

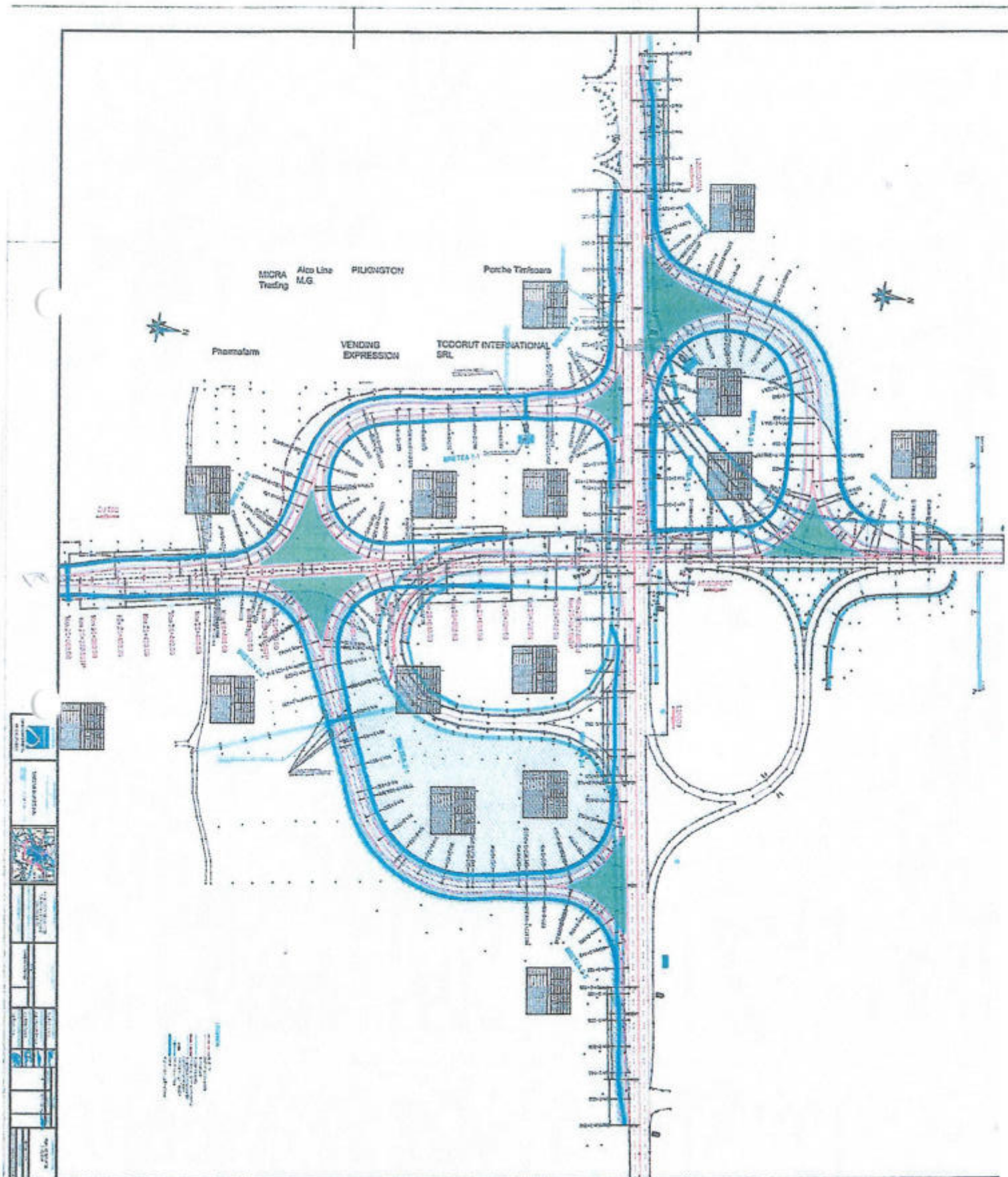
unde:

- d_i este intarzierea de control medie pe intersectie
- Q_x este debitul de calcul corespunzator miscarii x

4. Sinteza rezultatelor

Din analiza de capacitate de circulatie a nodului a rezultat intarzierea medie de control pe nod de $d_i = 14.7$ sec/vehicul la nivelul anului de prognoza 2040.

Nivelul de serviciu rezultat pentru nodul rutier la nivelul anului de prognoza 2040 va fi $N_s = B$ fiind in limita nivelului de serviciu recomandat pentru noduri de circulatie "C".



Fluxurile de trafic in nodul rutier

Anul 2040

A

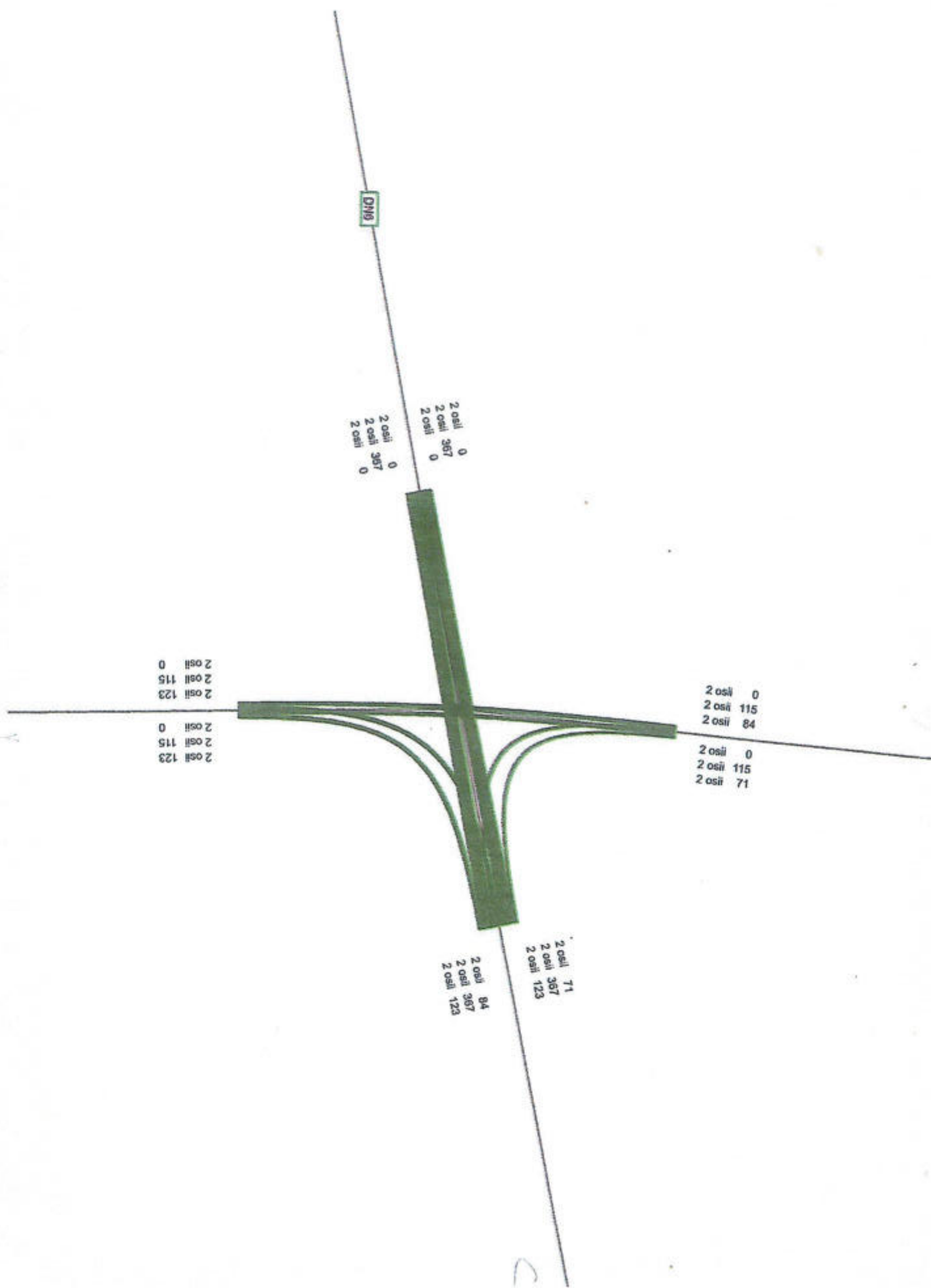
DM0

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Tur 0
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Tur 0
Tur 896
Tur 3309
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Tur 473
Tur 3309
Tur 5432
Tur 473

Tur 0
Tur 896
Tur 473
Tur 0
Tur 896
Tur 473



DN0

3/4 osii 0
3/4 osii 0
3/4 osii 0
3/4 osii 0
3/4 osii 0

3/4 osii 0
3/4 osii 117
3/4 osii 25
3/4 osii 0
3/4 osii 117
3/4 osii 25

3/4 osii 25
3/4 osii 0
3/4 osii 78
3/4 osii 25
3/4 osii 0
3/4 osii 78

3/4 osii 0
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3/4 osii 78
3/4 osii 0
3/4 osii 117
3/4 osii 78

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DMG

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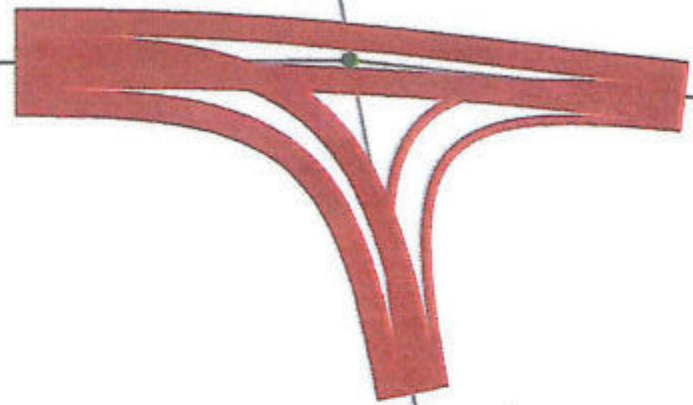
art 566
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INTERSECTIE VO TIMISOARA SUD – DJ 591

2020

DJ591

Tur 493
Tur 2791
Tur 493
Tur 2791

Tur 2791
Tur 479
Tur 2791
Tur 479

Tur 493
Tur 479
Tur 493
Tur 479

DJ591

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2 osli 0
2 osli 45
2 osli 0
2 osli 45

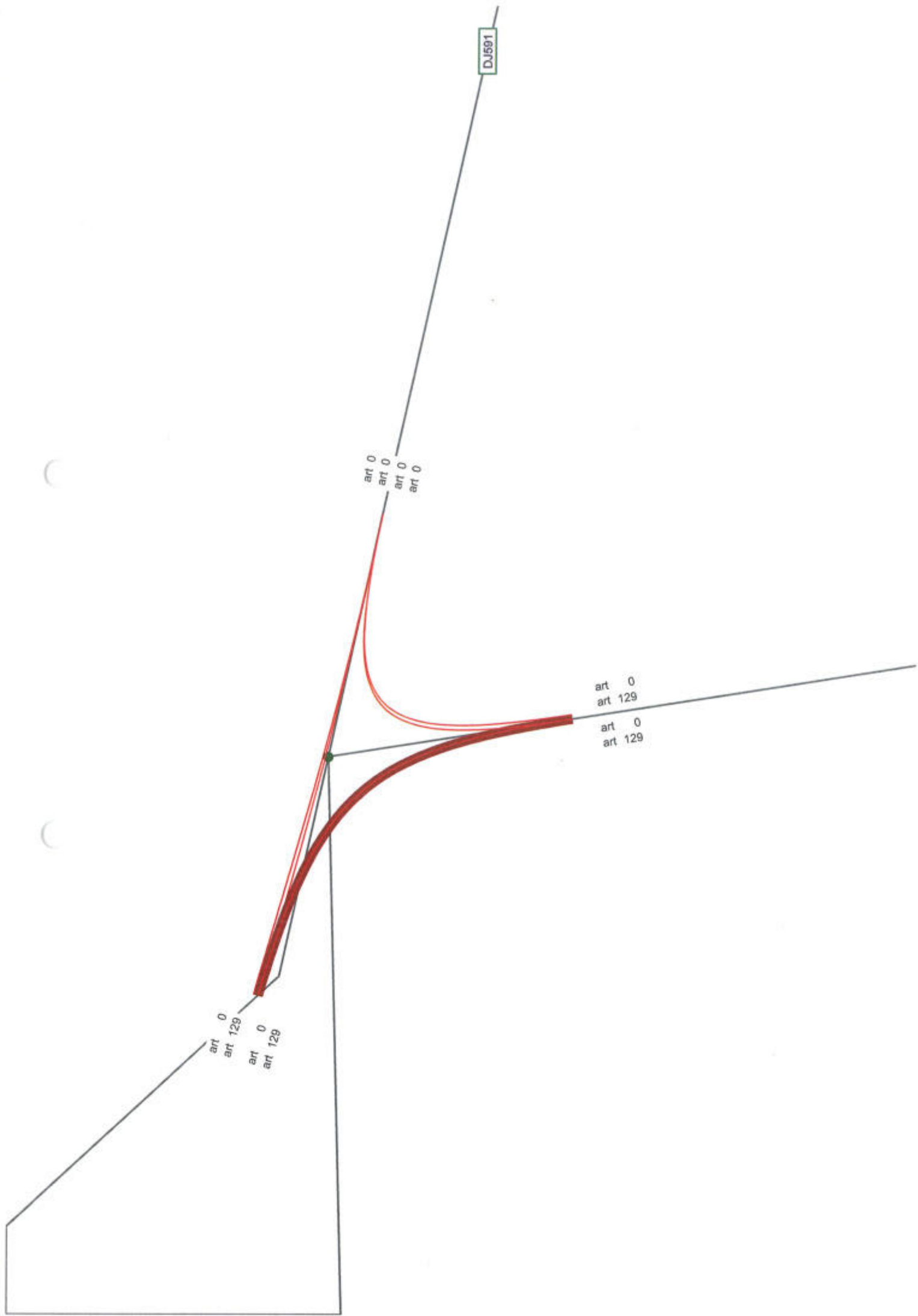
2 osli 0
2 osli 45
2 osli 0
2 osli 45

DJ591

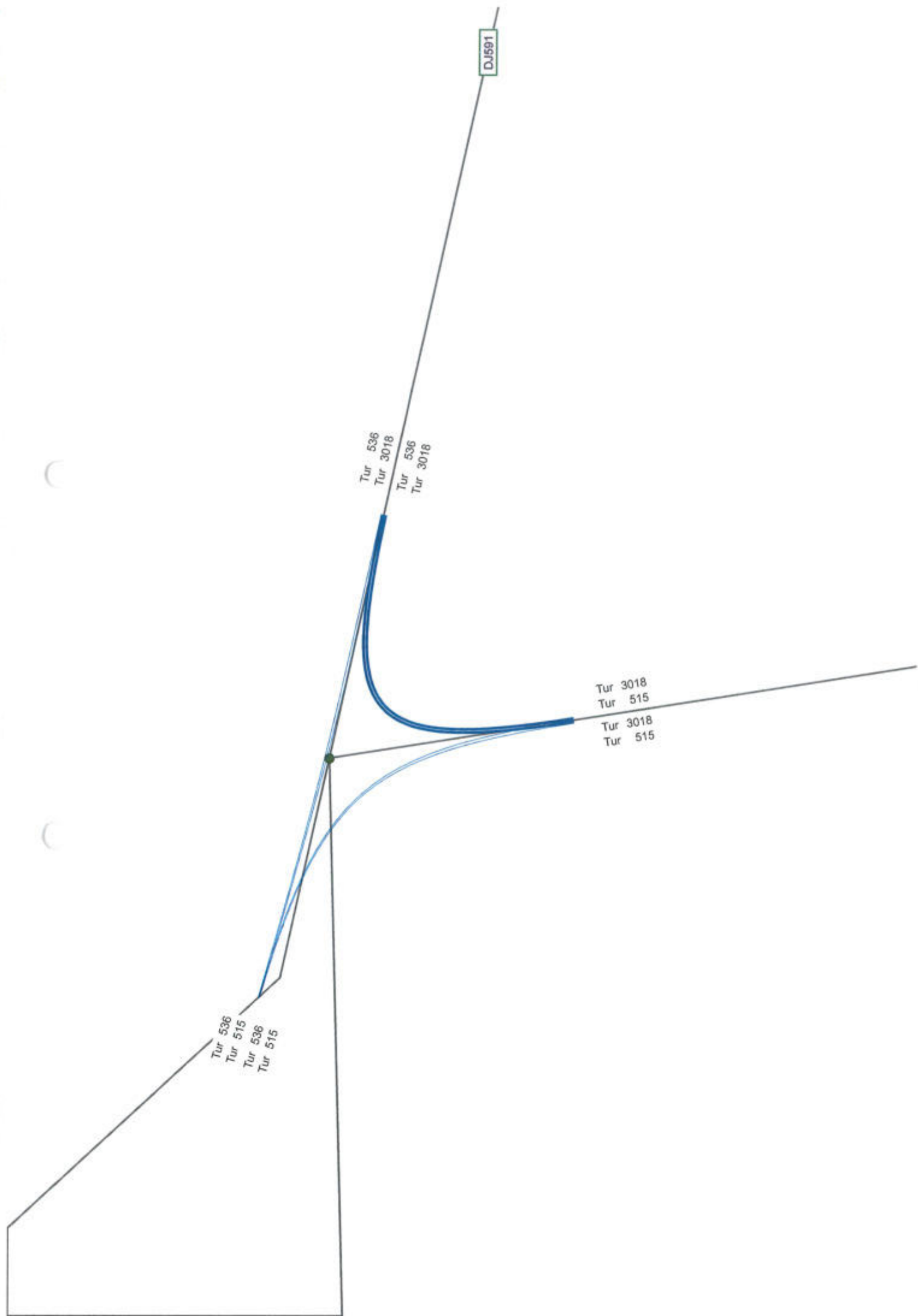
$\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 0

$\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 13
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 13

$\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 13
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 13



2025



DJ591

2 osli 0
2 osli 0
2 osli 0
2 osli 0

2 osli 0
2 osli 49
2 osli 0
2 osli 49

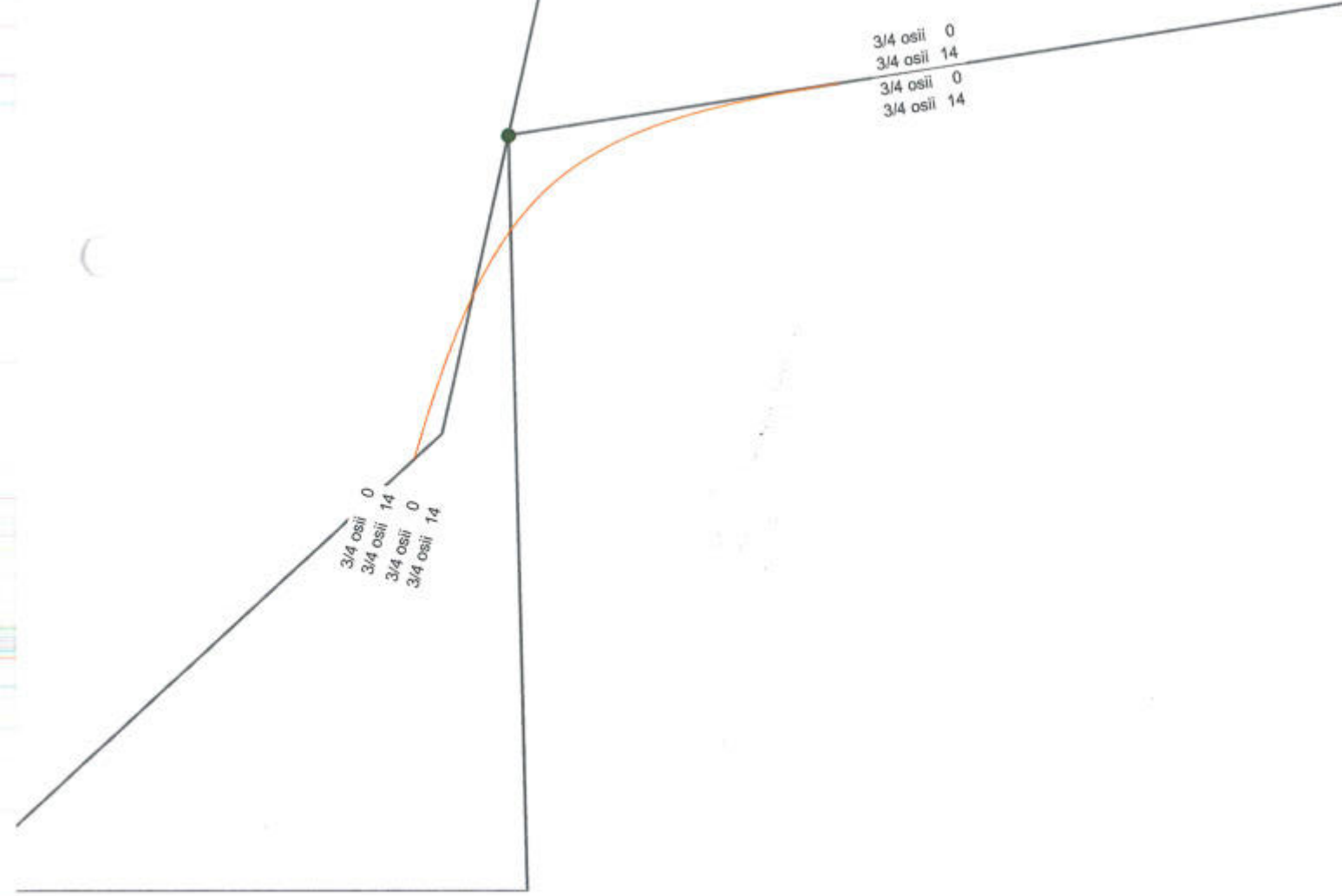
2 osli 0
2 osli 49
2 osli 0
2 osli 49

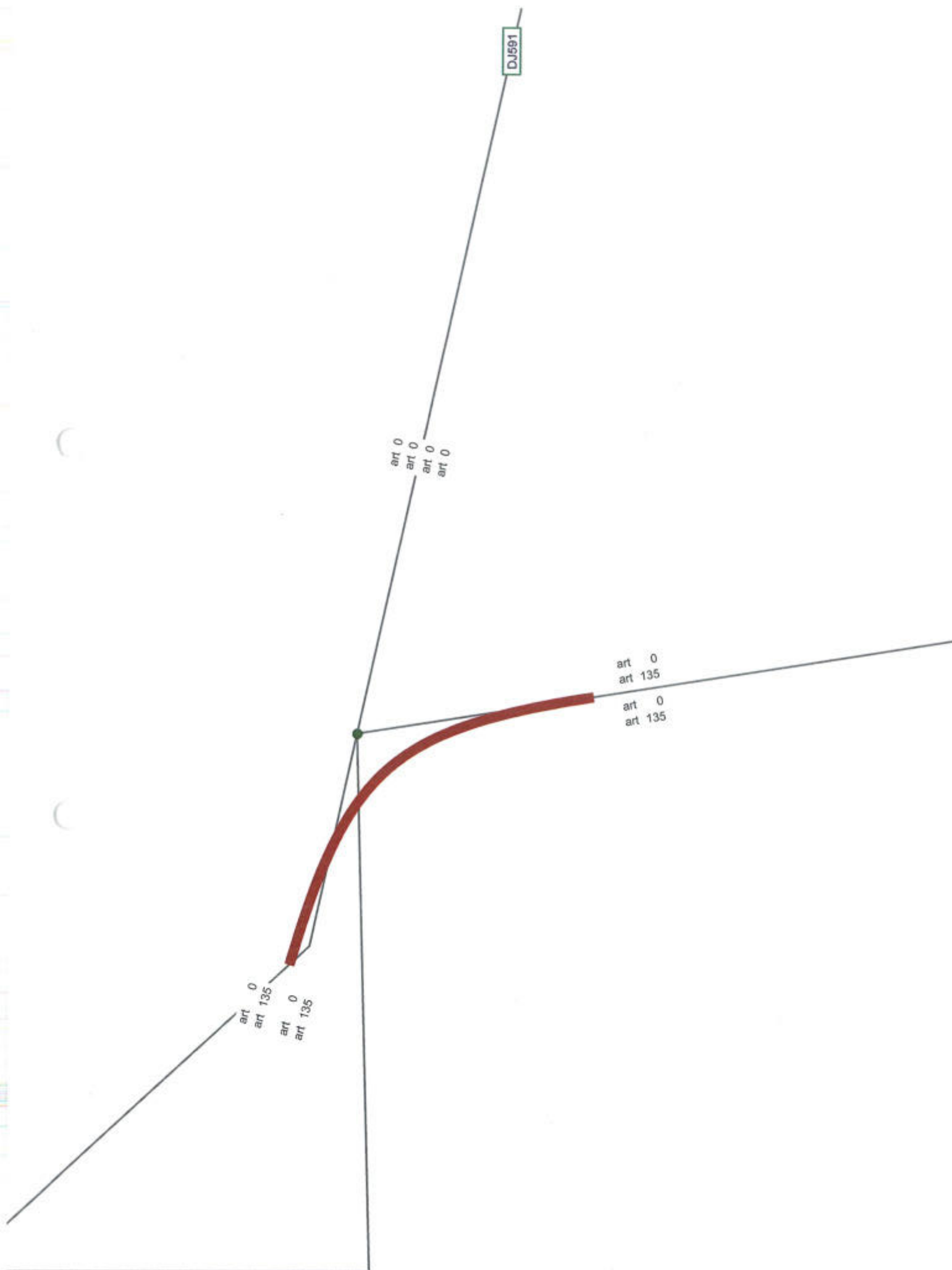
DJ591

$\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 0

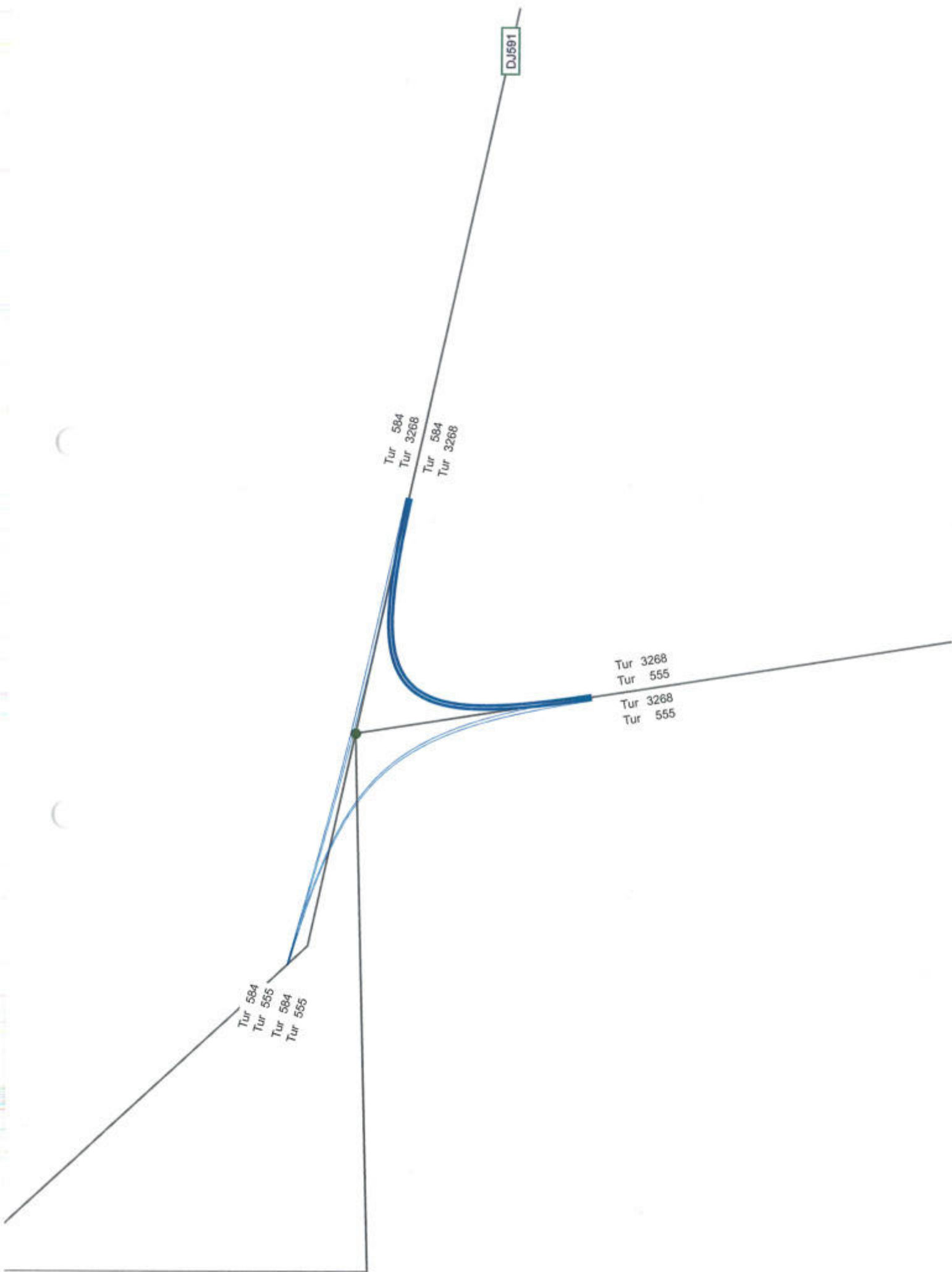
$\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 14
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 14

$\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 14
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 14





2030



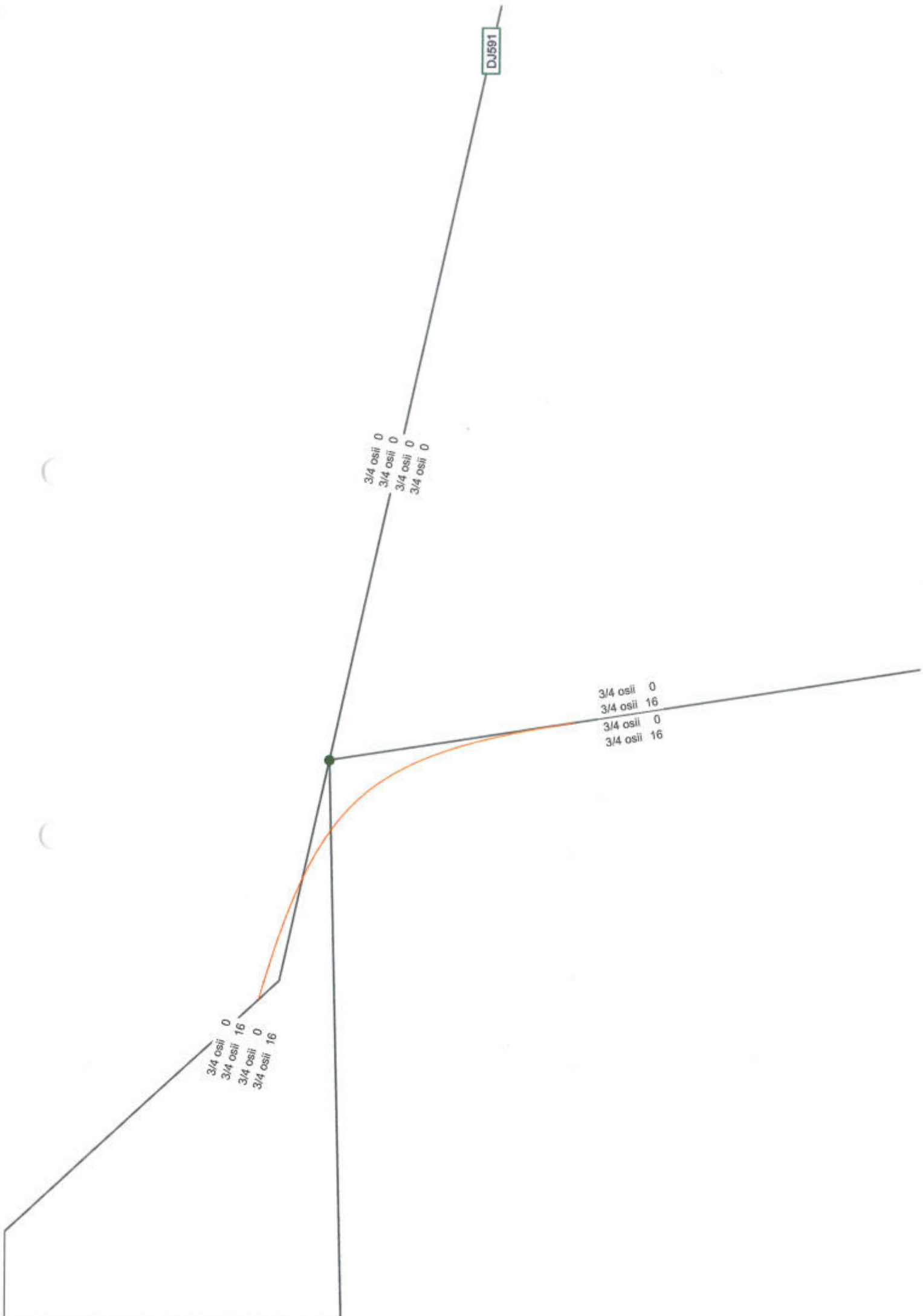


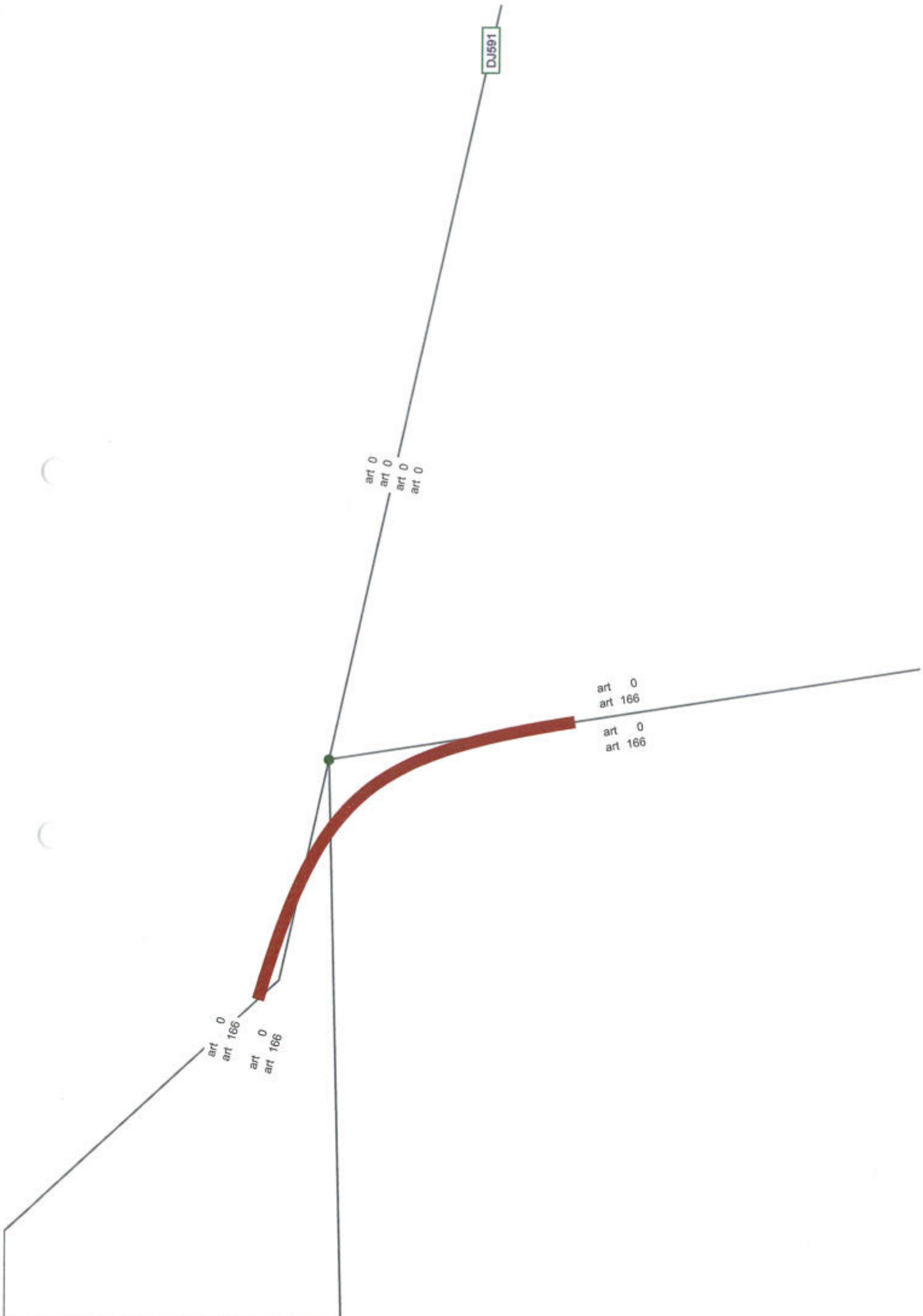
DJ591

$\frac{3}{4}$ osii 0
 $\frac{3}{4}$ osii 0
 $\frac{3}{4}$ osii 0
 $\frac{3}{4}$ osii 0

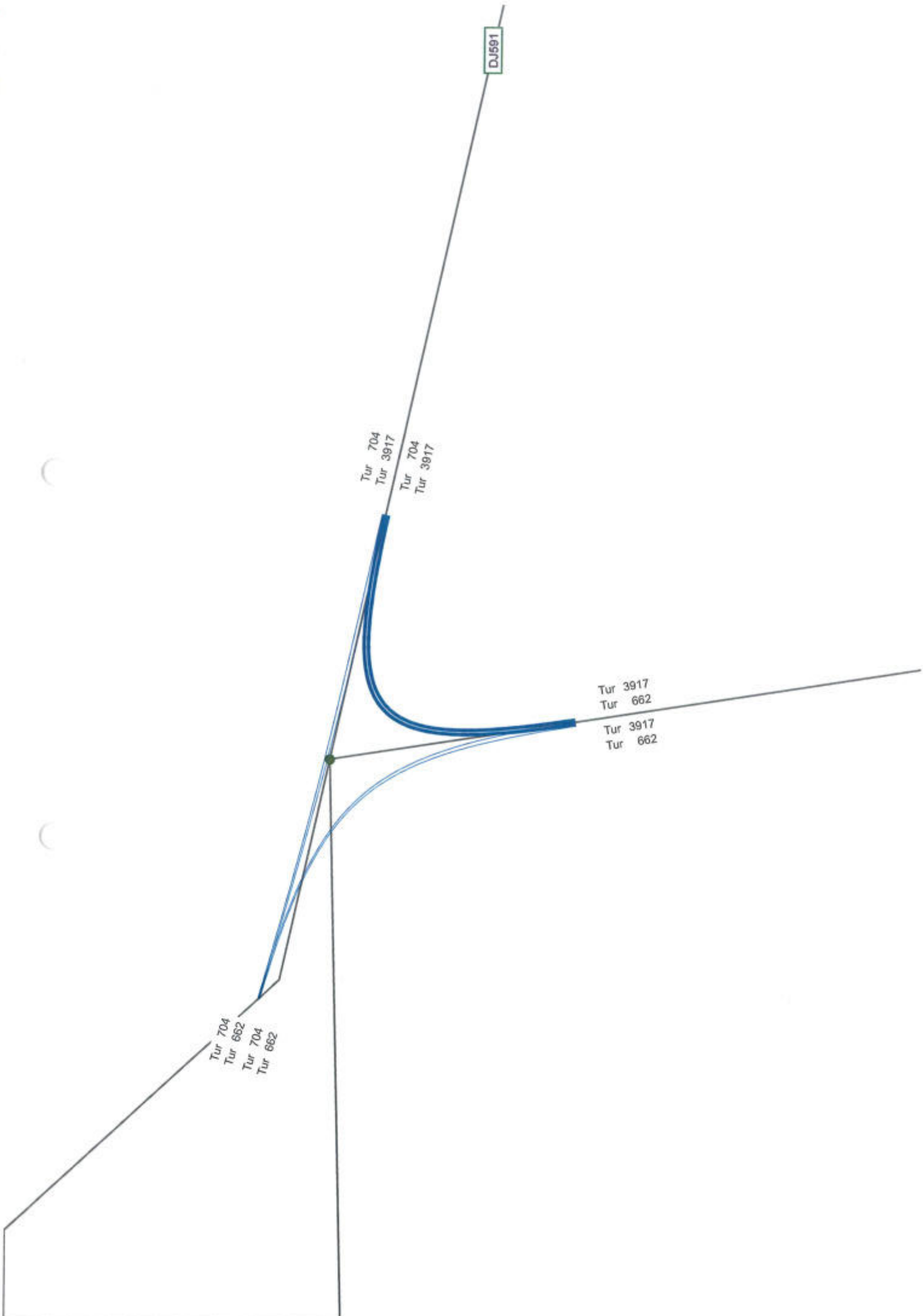
$\frac{3}{4}$ osii 0
 $\frac{3}{4}$ osii 16
 $\frac{3}{4}$ osii 0
 $\frac{3}{4}$ osii 16

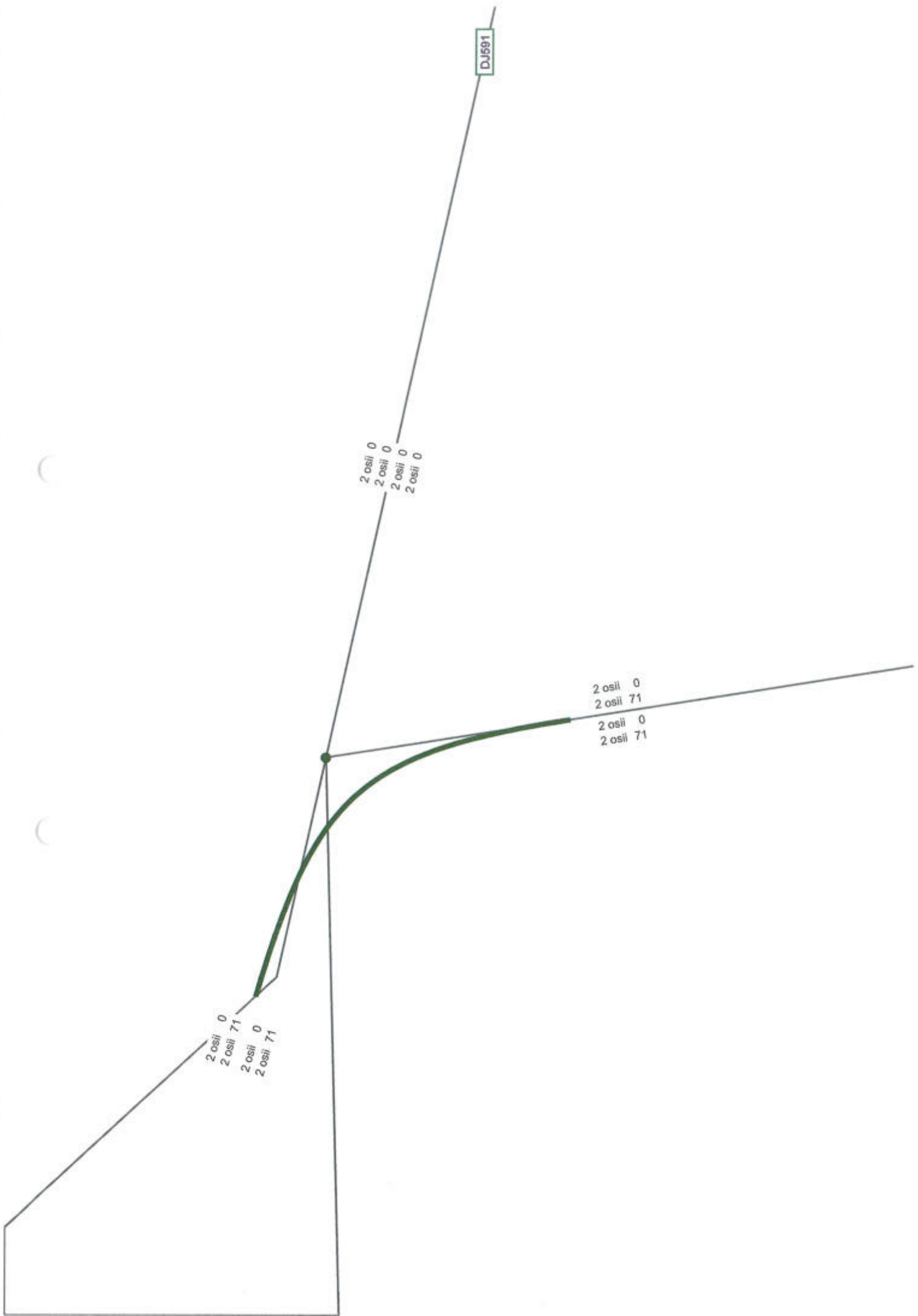
$\frac{3}{4}$ osii 0
 $\frac{3}{4}$ osii 16
 $\frac{3}{4}$ osii 0
 $\frac{3}{4}$ osii 16





2035



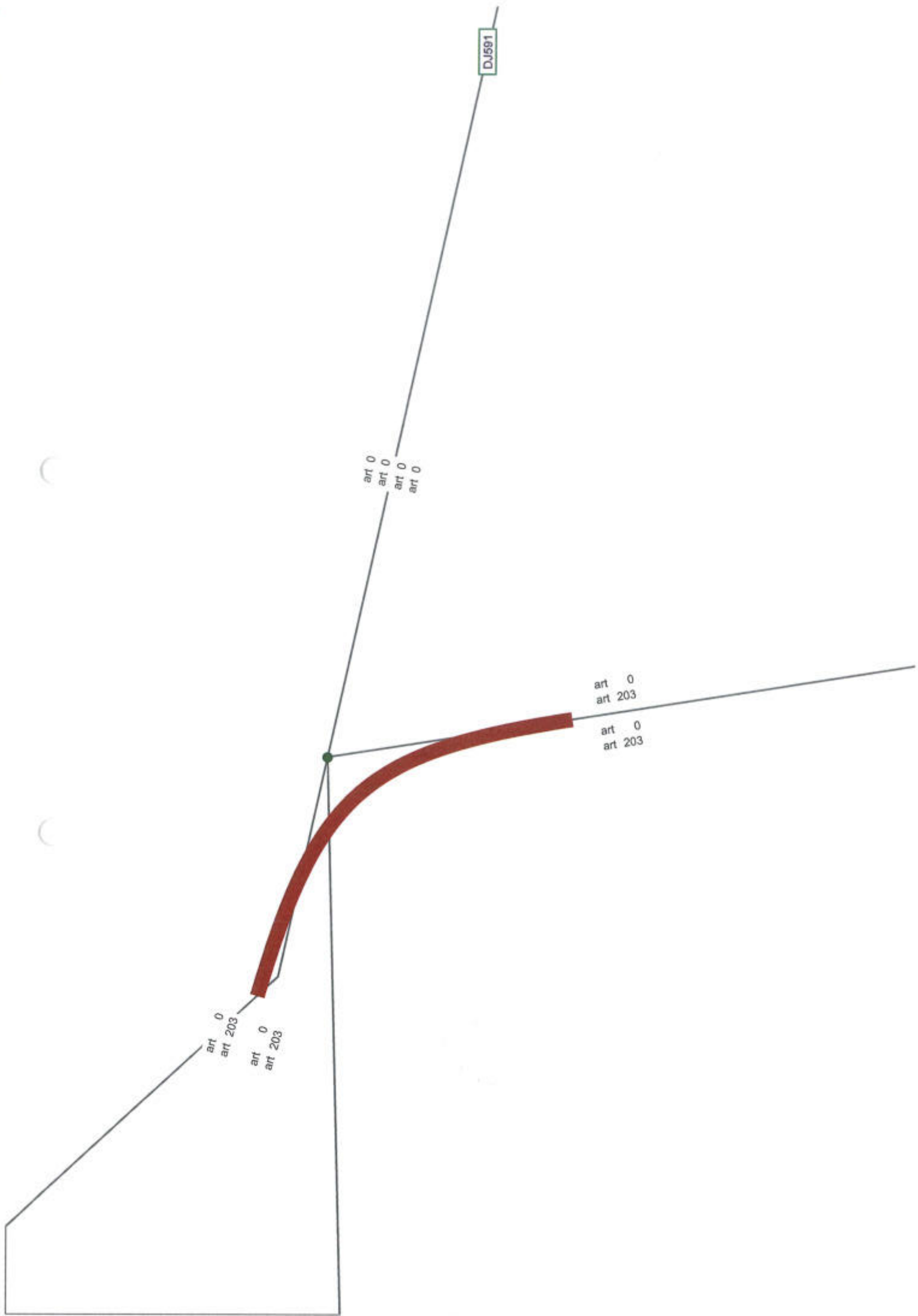


DJ591

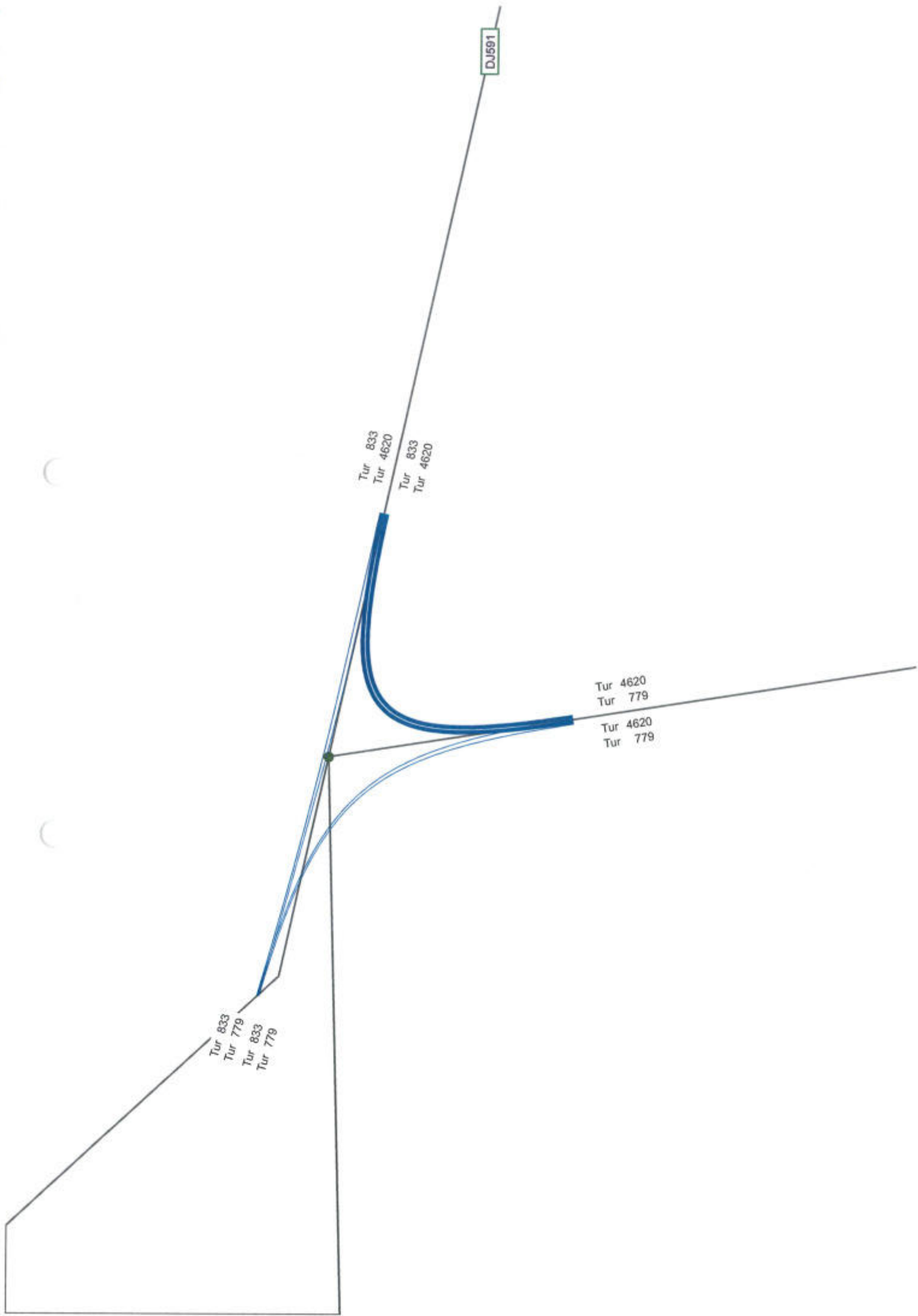
$\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 0

$\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 19
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 19

$\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 19
 $\frac{3}{4}$ osli 0
 $\frac{3}{4}$ osli 19



2040

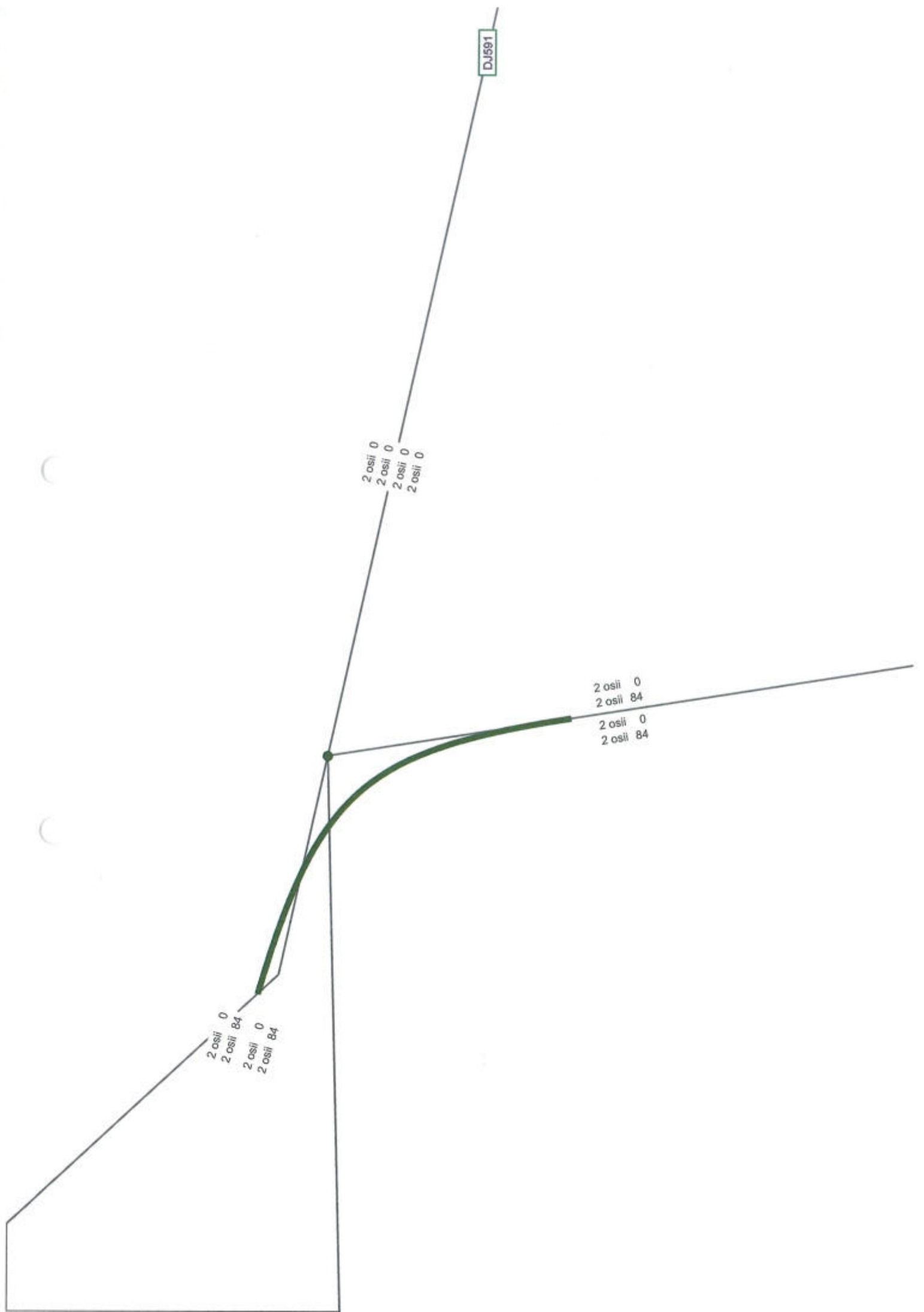


DJ/591

2 osli 0
2 osli 0
2 osli 0
2 osli 0

2 osli 0
2 osli 84
2 osli 0
2 osli 84

2 osli 0
2 osli 84
2 osli 0
2 osli 84



DJ591

$\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 0

$\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 21
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 21

$\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 21
 $\frac{3}{4}$ osil 0
 $\frac{3}{4}$ osil 21

DJ591

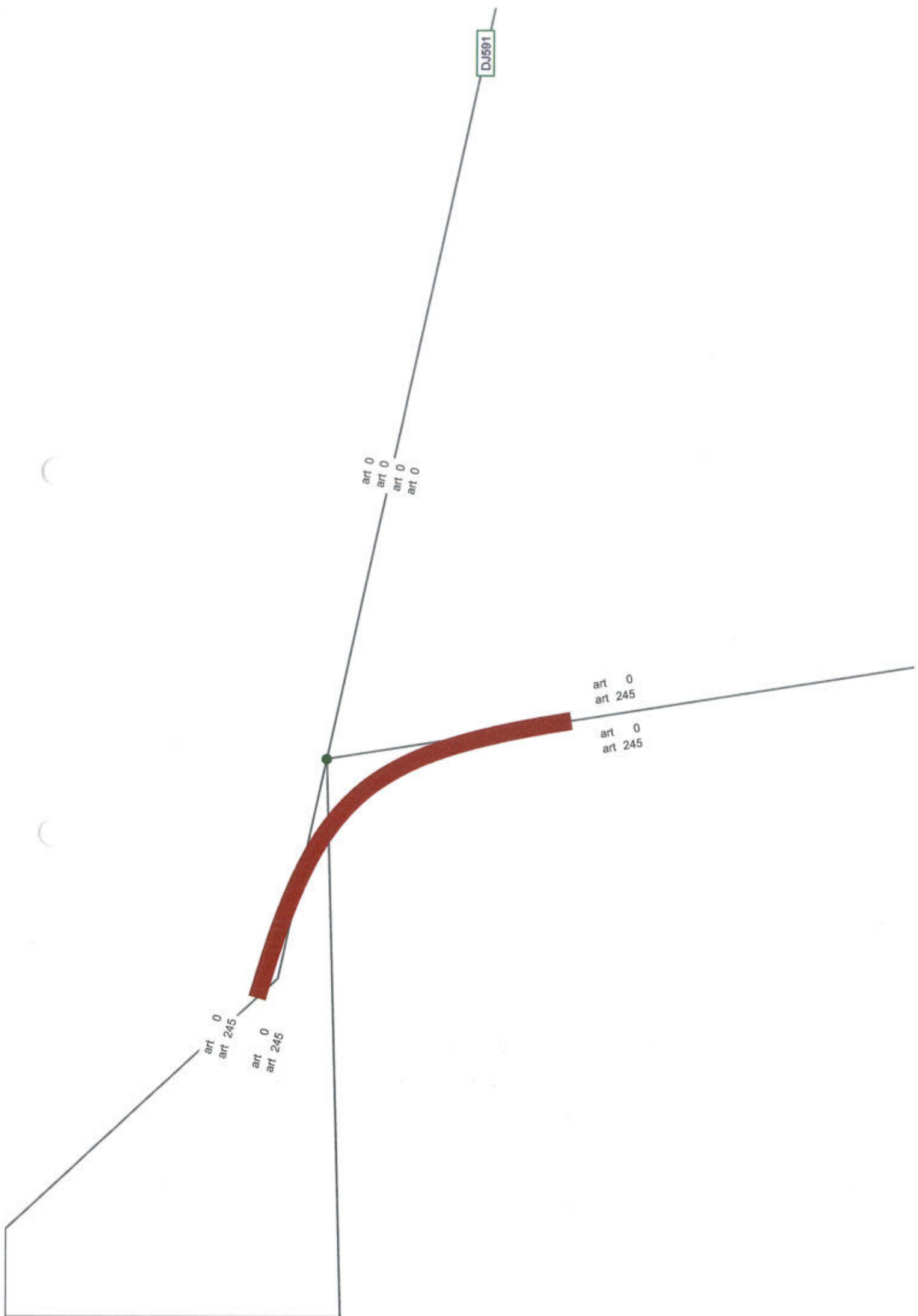
art 0
art 0
art 0
art 0

art 0
art 245

art 0
art 245

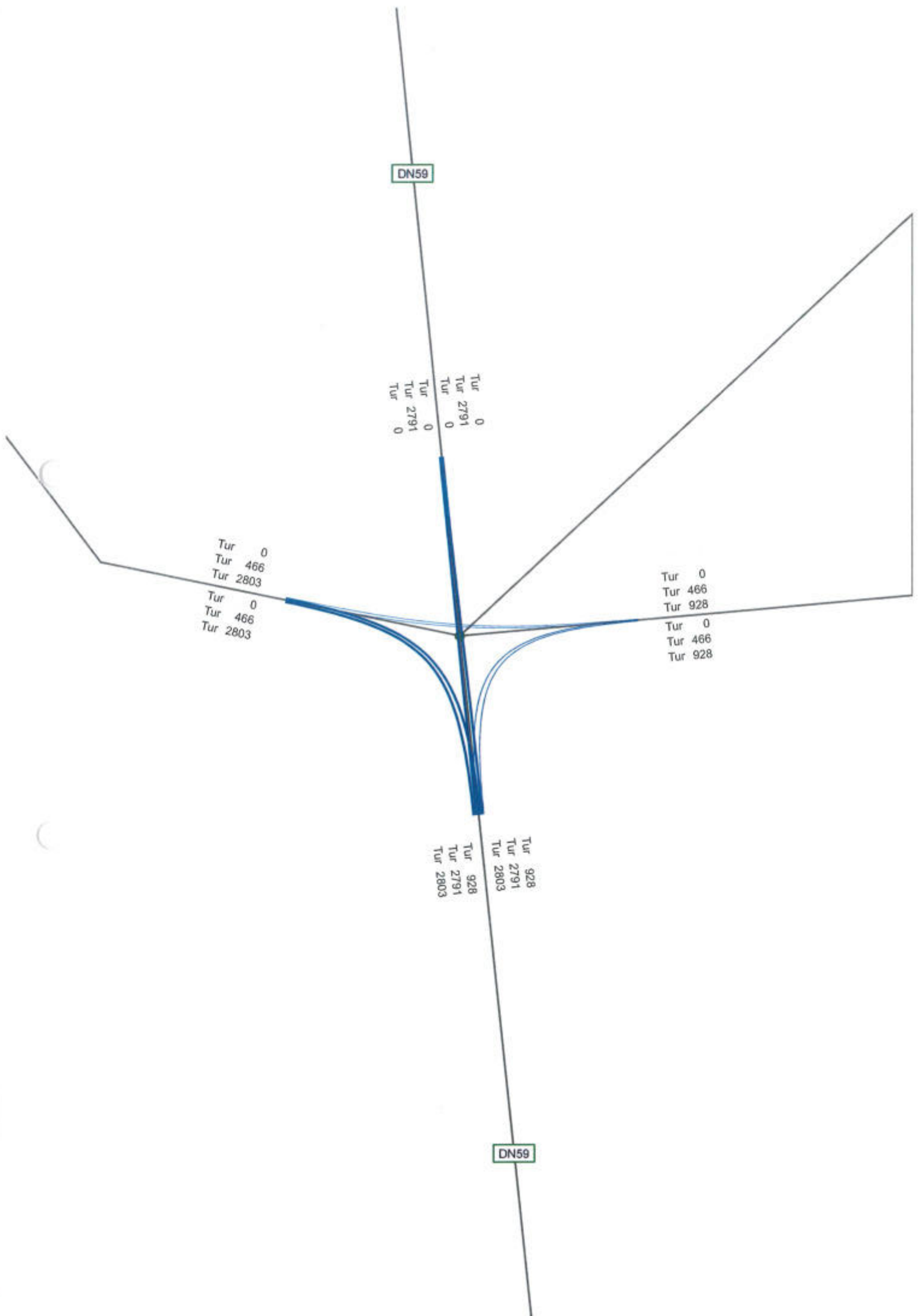
art 0
art 245

art 0
art 245



INTERSECTIE VO TIMISOARA SUD – DN 59

2020



DN59

2 osli 0
2 osli 95
2 osli 45
2 osli 0
2 osli 95
2 osli 45

2 osli 45
2 osli 0
2 osli 0
2 osli 45
2 osli 0
2 osli 0

2 osli 0
2 osli 0
2 osli 53
2 osli 0
2 osli 0
2 osli 53

2 osli 53
2 osli 95
2 osli 0
2 osli 53
2 osli 95
2 osli 0

DN59

DN59

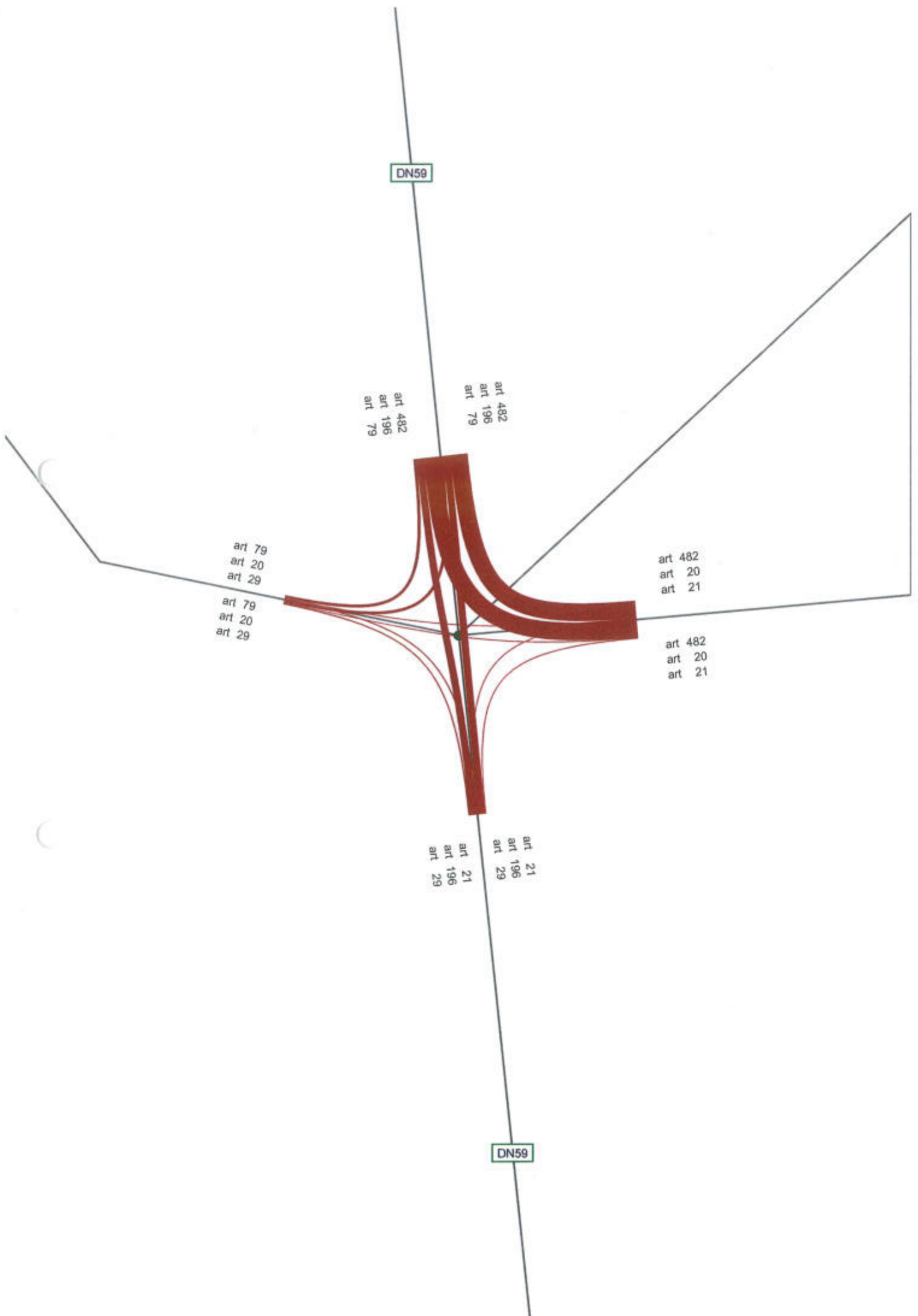
3/4 osil 94
3/4 osil 24
3/4 osil 0

3/4 osil 0
3/4 osil 0
3/4 osil 13
3/4 osil 0
3/4 osil 0
3/4 osil 13

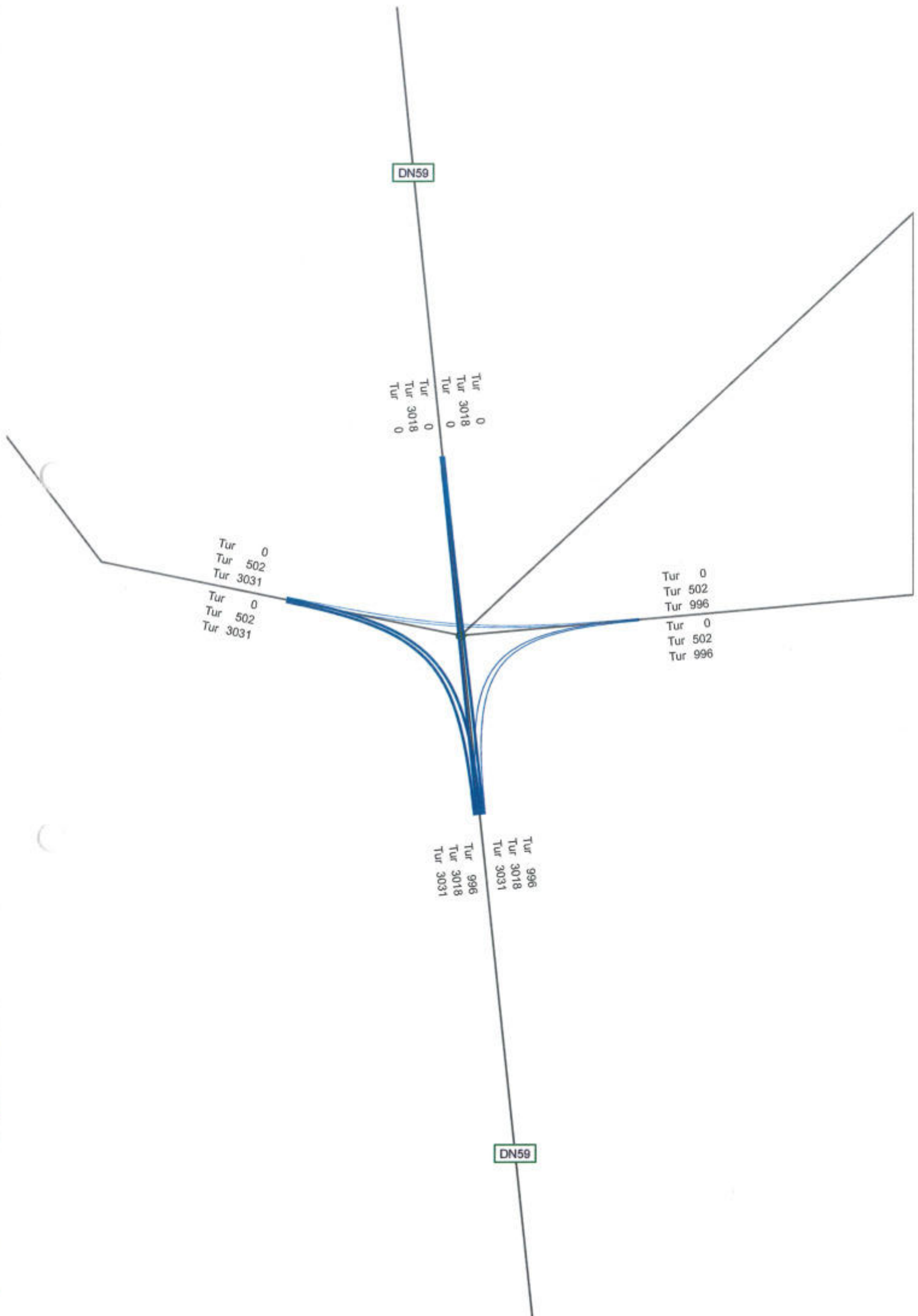
3/4 osil 94
3/4 osil 0
3/4 osil 8
3/4 osil 94
3/4 osil 0
3/4 osil 8

3/4 osil 8
3/4 osil 24
3/4 osil 13
3/4 osil 8
3/4 osil 24
3/4 osil 13

DN59



2025



DN59

2 osli 0
2 osli 104
2 osli 49
2 osli 0
2 osli 104
2 osli 49

2 osli 49
2 osli 0
2 osli 0
2 osli 49
2 osli 0
2 osli 0

2 osli 0
2 osli 0
2 osli 57
2 osli 0
2 osli 0
2 osli 57

2 osli 57
2 osli 104
2 osli 0
2 osli 57
2 osli 104
2 osli 0

DN59

DN59

3/4 osli 97
3/4 osli 25
3/4 osli 0
3/4 osli 97
3/4 osli 25
3/4 osli 0

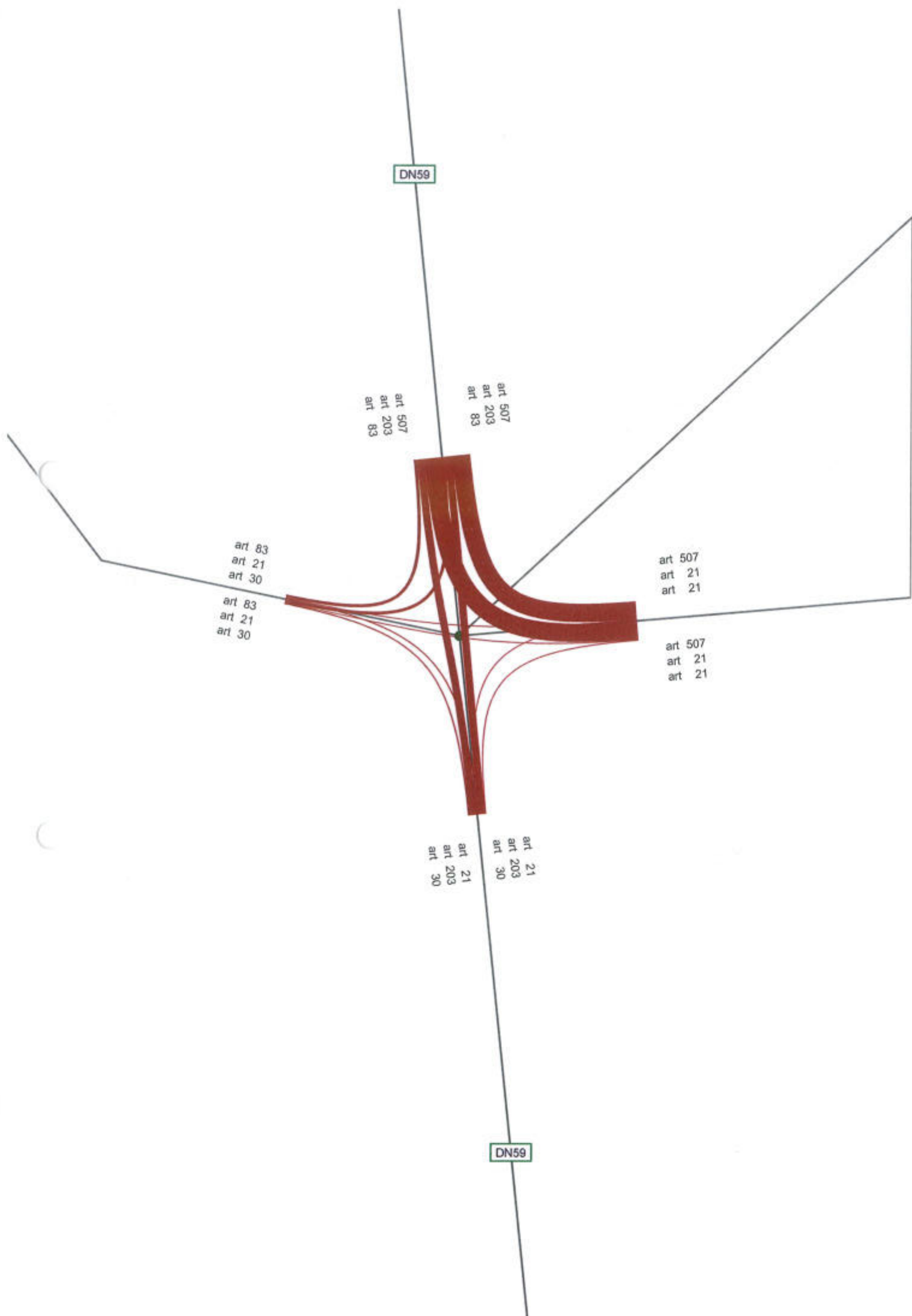
3/4 osli 0
3/4 osli 0
3/4 osli 14
3/4 osli 0
3/4 osli 0
3/4 osli 14

3/4 osli 97
3/4 osli 0
3/4 osli 8

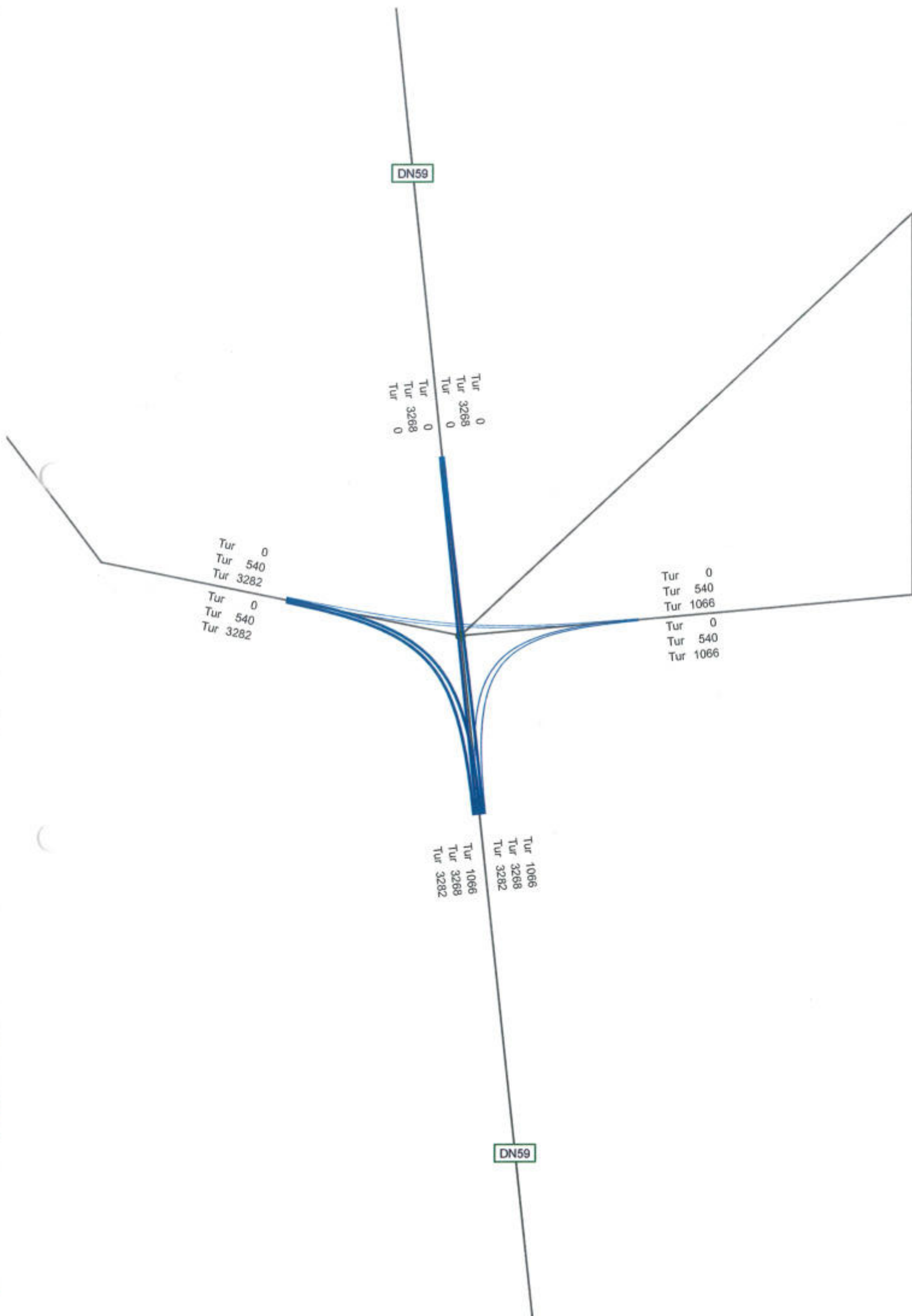
3/4 osli 97
3/4 osli 0
3/4 osli 8

3/4 osli 8
3/4 osli 25
3/4 osli 14
3/4 osli 8
3/4 osli 25
3/4 osli 14

DN59



2030



DN59

2 osii 0
2 osii 124
2 osii 59
2 osii 0
2 osii 124
2 osii 59

2 osii 59
2 osii 0
2 osii 0
2 osii 59
2 osii 0
2 osii 0

2 osii 0
2 osii 0
2 osii 68
2 osii 0
2 osii 0
2 osii 68

2 osii 68
2 osii 124
2 osii 0
2 osii 68
2 osii 124
2 osii 0

DN59

DN59

3/4 osil 113
3/4 osil 29
3/4 osil 0
3/4 osil 113
3/4 osil 29
3/4 osil 0

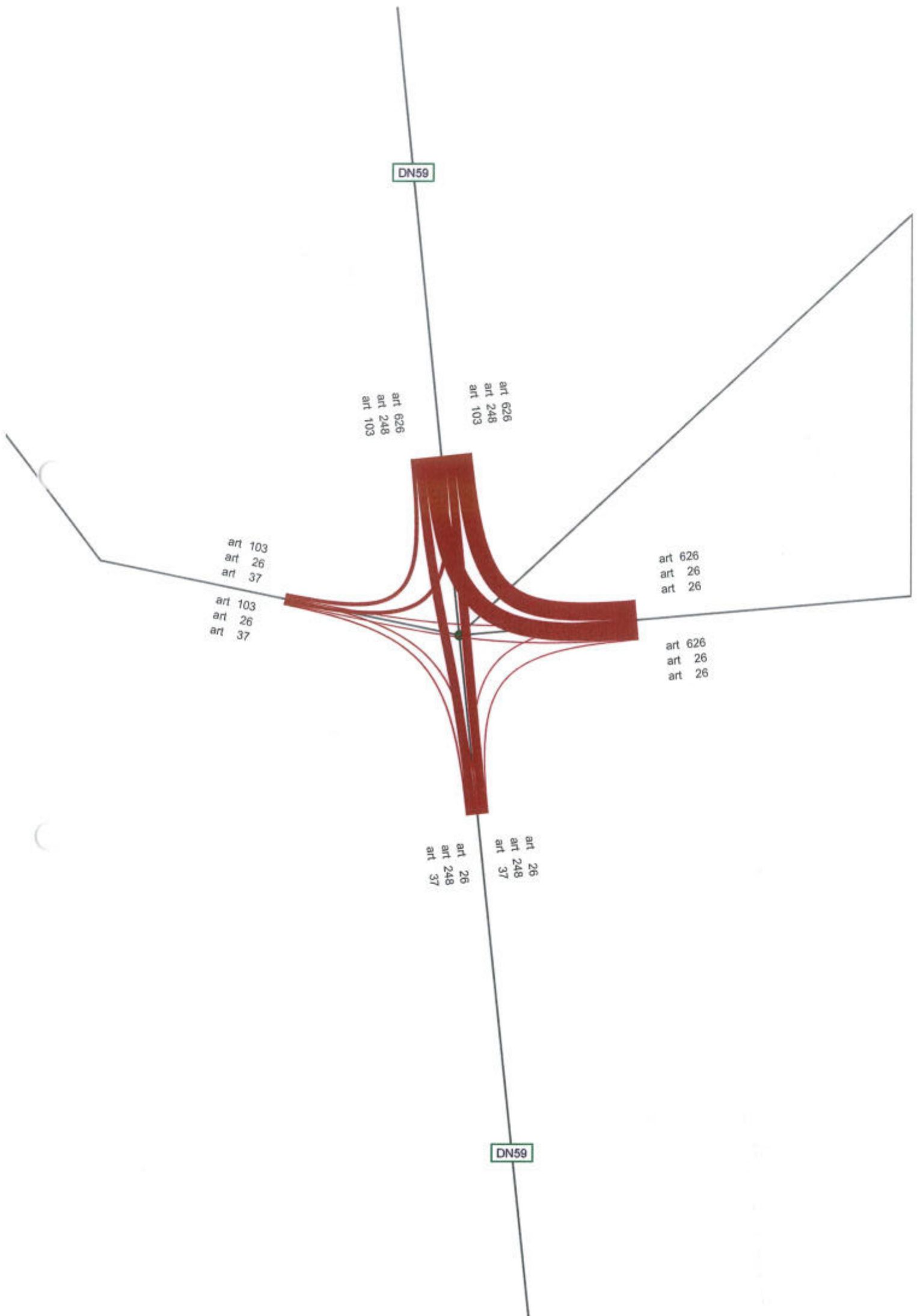
3/4 osil 0
3/4 osil 0
3/4 osil 16
3/4 osil 0
3/4 osil 0
3/4 osil 16

3/4 osil 113
3/4 osil 0
3/4 osil 10

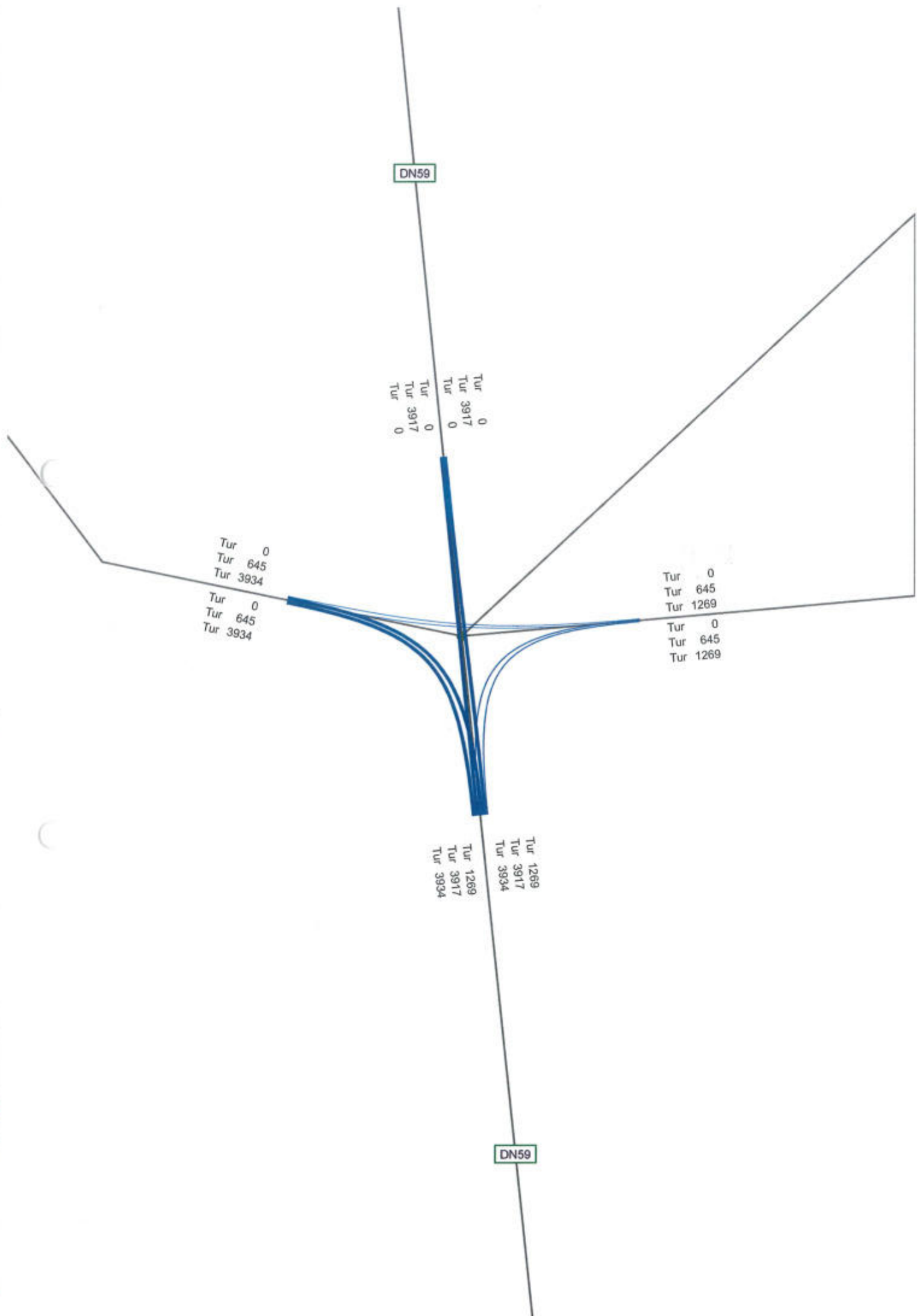
3/4 osil 113
3/4 osil 0
3/4 osil 10

3/4 osil 10
3/4 osil 29
3/4 osil 16
3/4 osil 10
3/4 osil 29
3/4 osil 16

DN59



2035



DN59

2 osli 0
2 osli 147
2 osli 71
2 osli 0
2 osli 147
2 osli 71

2 osli 71
2 osli 0
2 osli 0
2 osli 71
2 osli 0
2 osli 0

2 osli 0
2 osli 0
2 osli 81
2 osli 0
2 osli 0
2 osli 81

2 osli 81
2 osli 147
2 osli 0
2 osli 81
2 osli 147
2 osli 0

DN59

DN59

3/4 osli 133
3/4 osli 34
3/4 osli 0
3/4 osli 133
3/4 osli 34
3/4 osli 0

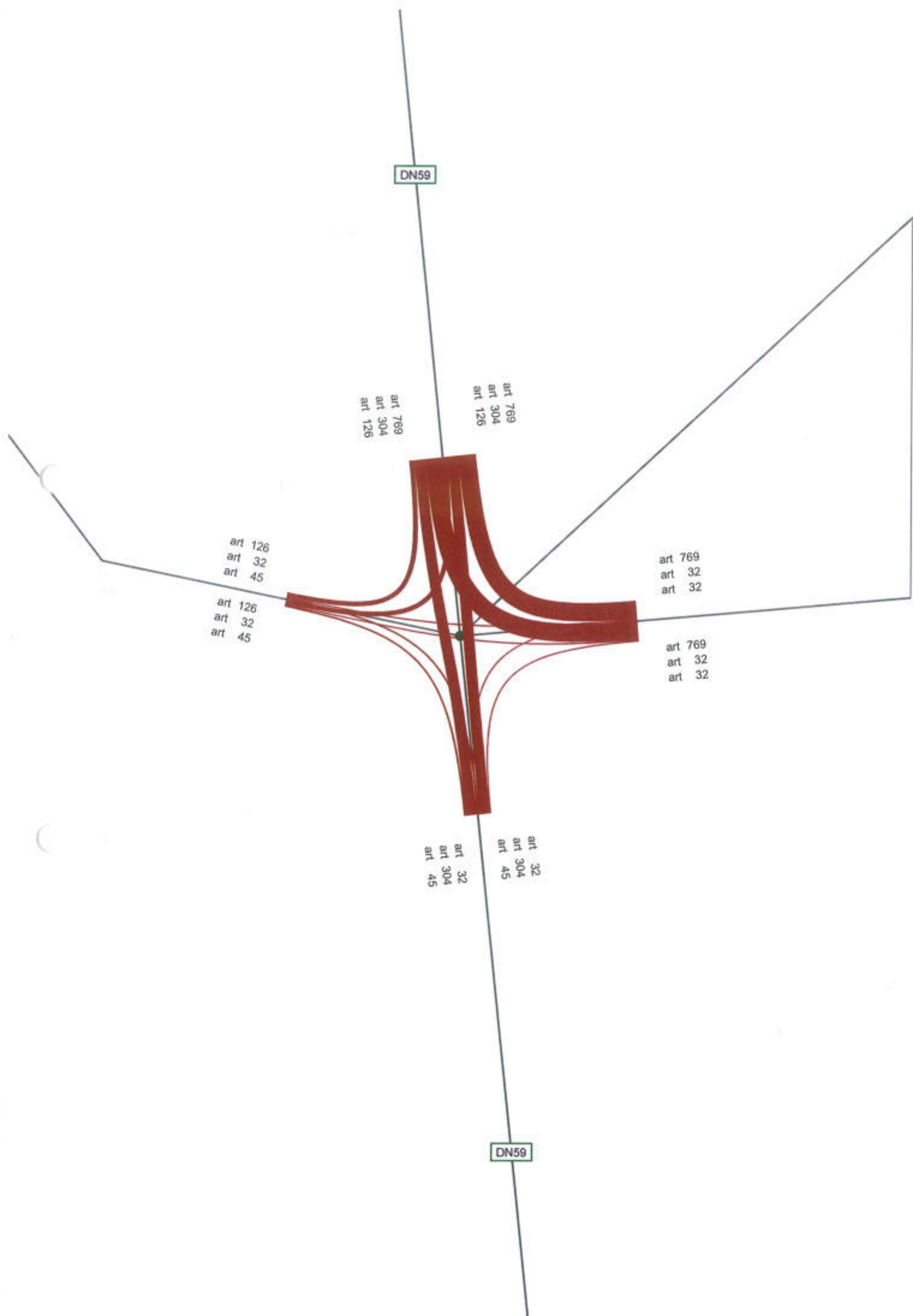
3/4 osli 0
3/4 osli 0
3/4 osli 19
3/4 osli 0
3/4 osli 0
3/4 osli 19

3/4 osli 133
3/4 osli 0
3/4 osli 12

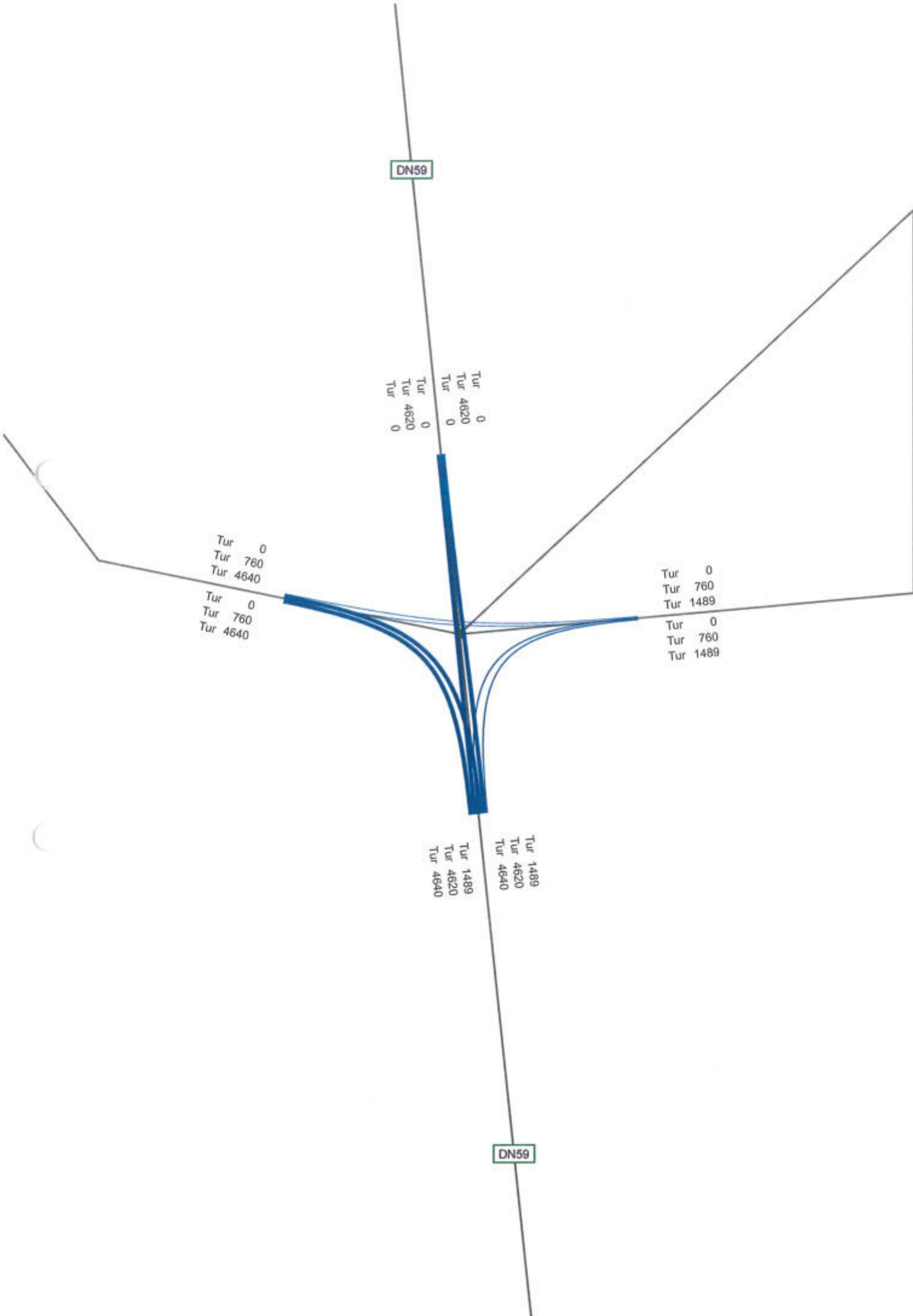
3/4 osli 133
3/4 osli 0
3/4 osli 12

3/4 osli 12
3/4 osli 34
3/4 osli 19
3/4 osli 12
3/4 osli 34
3/4 osli 19

DN59



2040



DN59

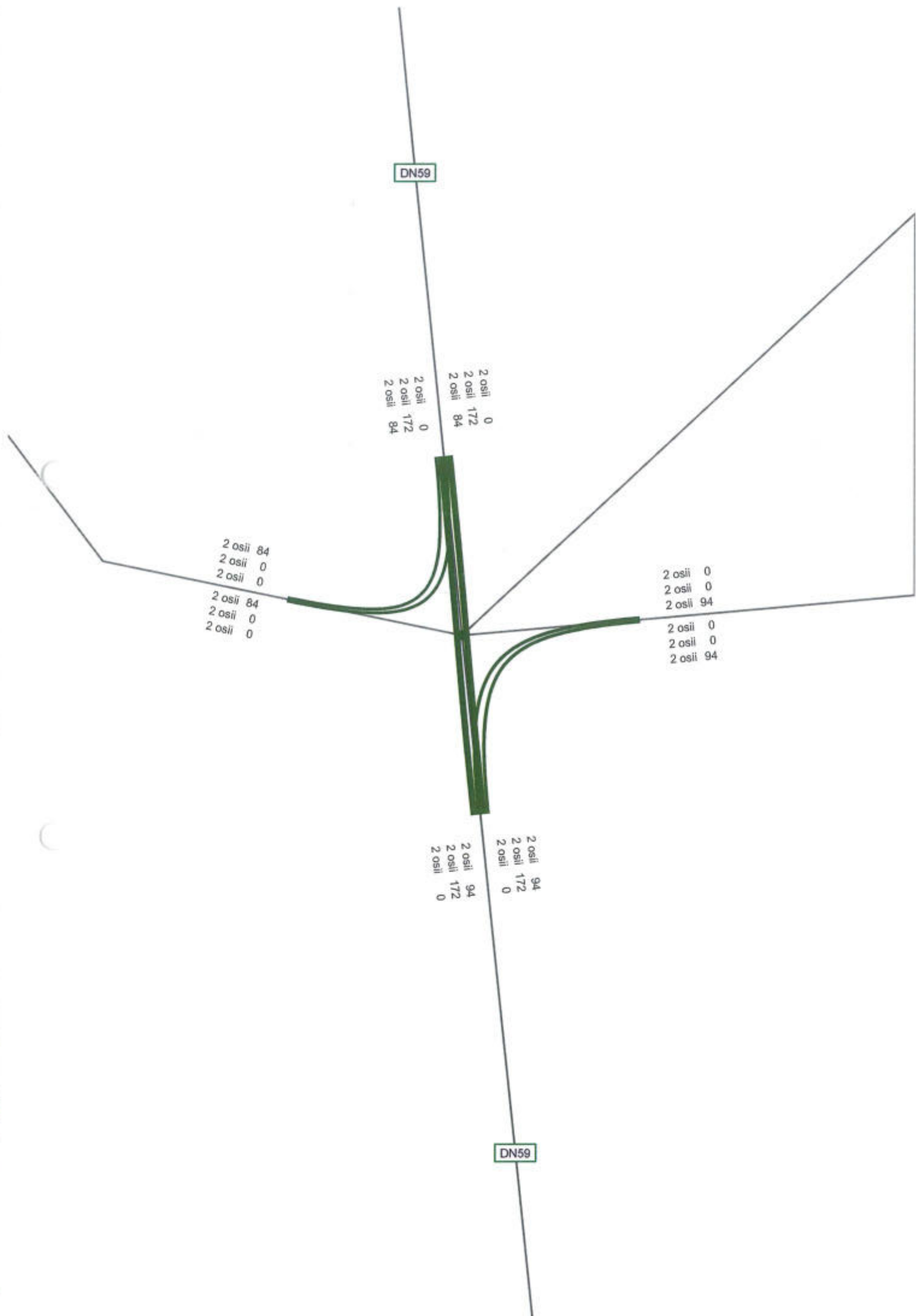
Tur 0
Tur 4620
Tur 0
Tur 0
Tur 4620
Tur 0

Tur 0
Tur 760
Tur 4640
Tur 0
Tur 760
Tur 4640

Tur 0
Tur 760
Tur 1489
Tur 0
Tur 760
Tur 1489

Tur 1489
Tur 4620
Tur 4640
Tur 1489
Tur 4620
Tur 4640

DN59



DN59

3/4 osii 153
3/4 osii 39
3/4 osii 0
3/4 osii 153
3/4 osii 39
3/4 osii 0

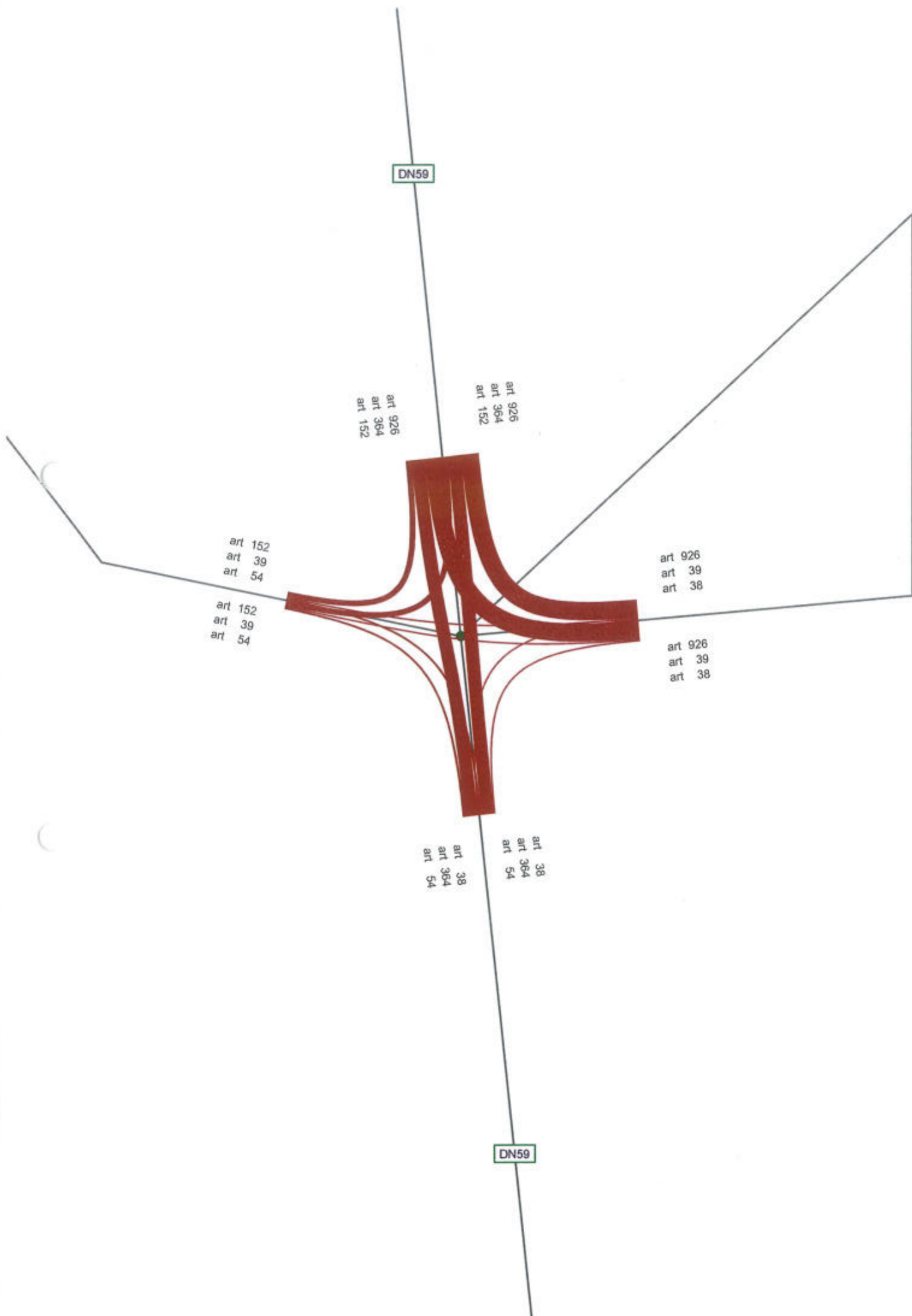
3/4 osii 0
3/4 osii 0
3/4 osii 21
3/4 osii 0
3/4 osii 0
3/4 osii 21

3/4 osii 153
3/4 osii 0
3/4 osii 13

3/4 osii 153
3/4 osii 0
3/4 osii 13

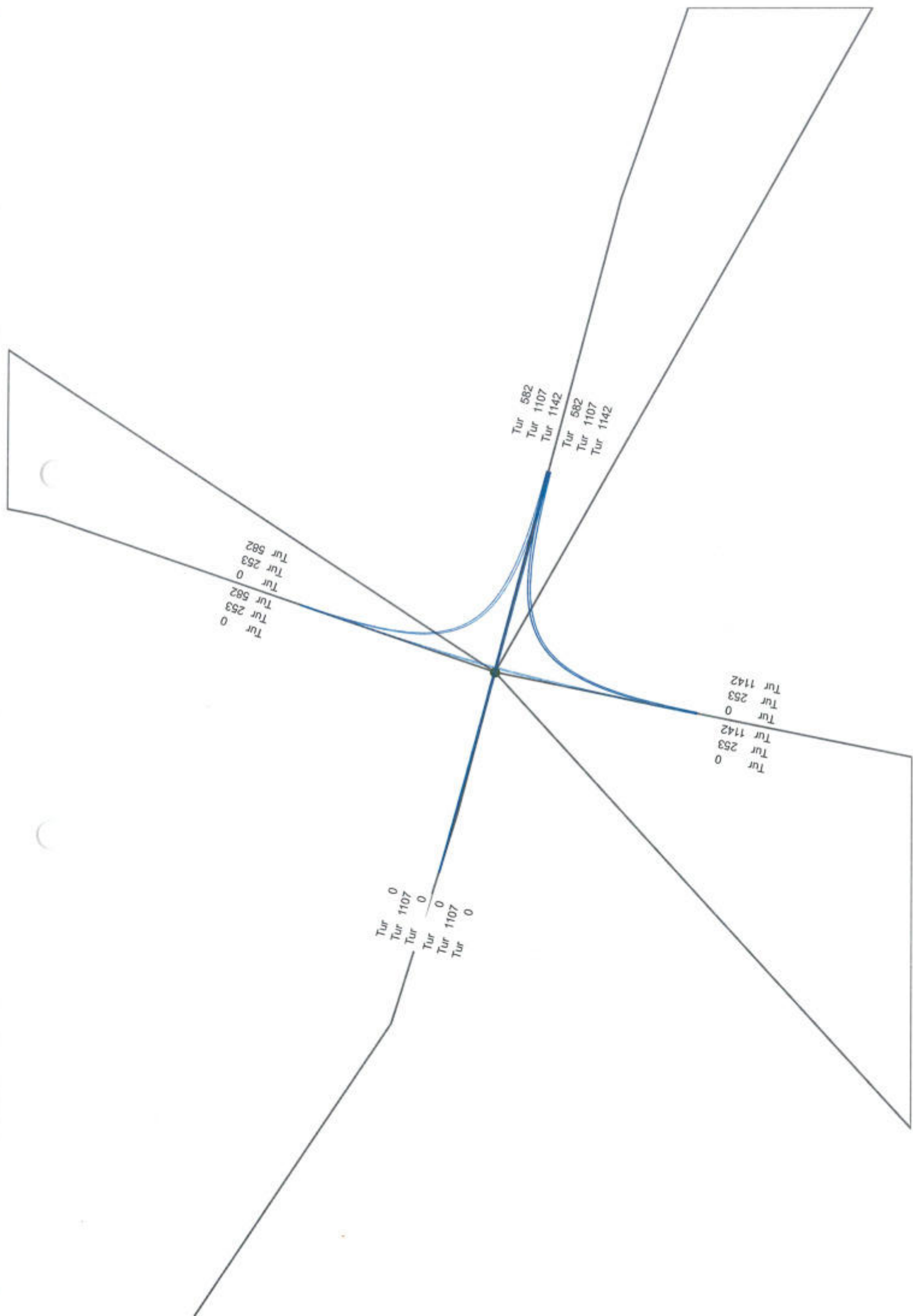
3/4 osii 13
3/4 osii 39
3/4 osii 21
3/4 osii 13
3/4 osii 39
3/4 osii 21

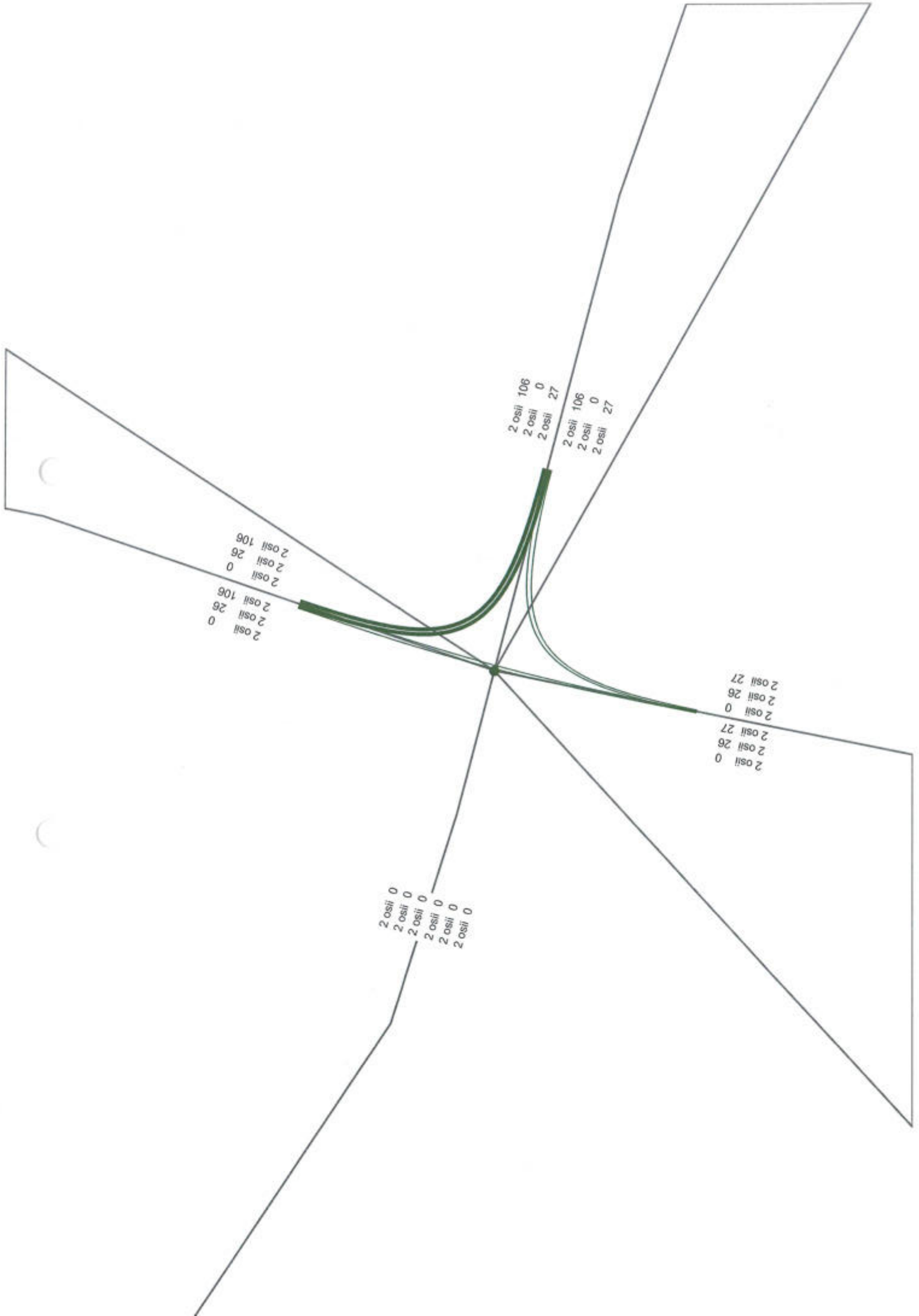
DN59

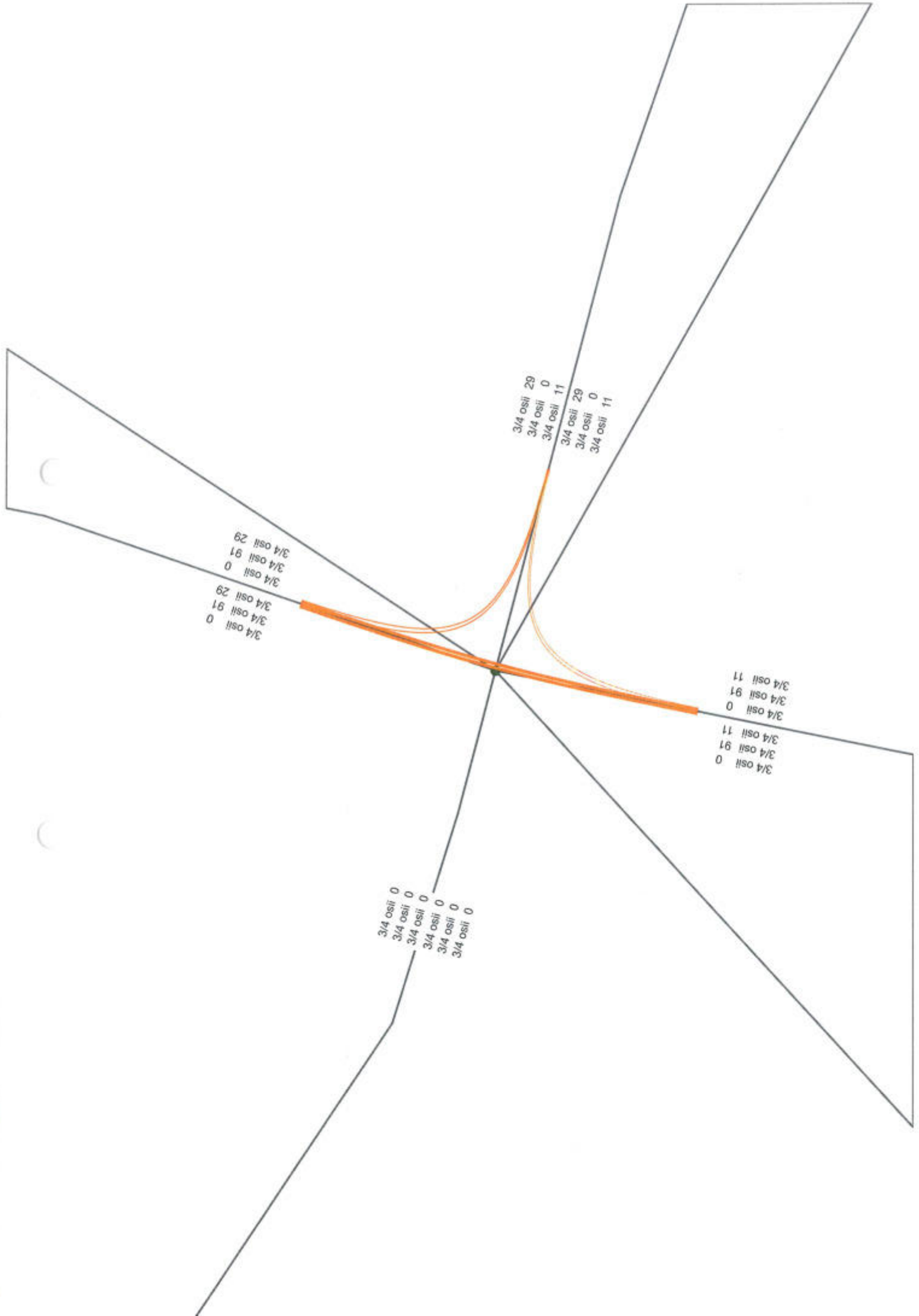


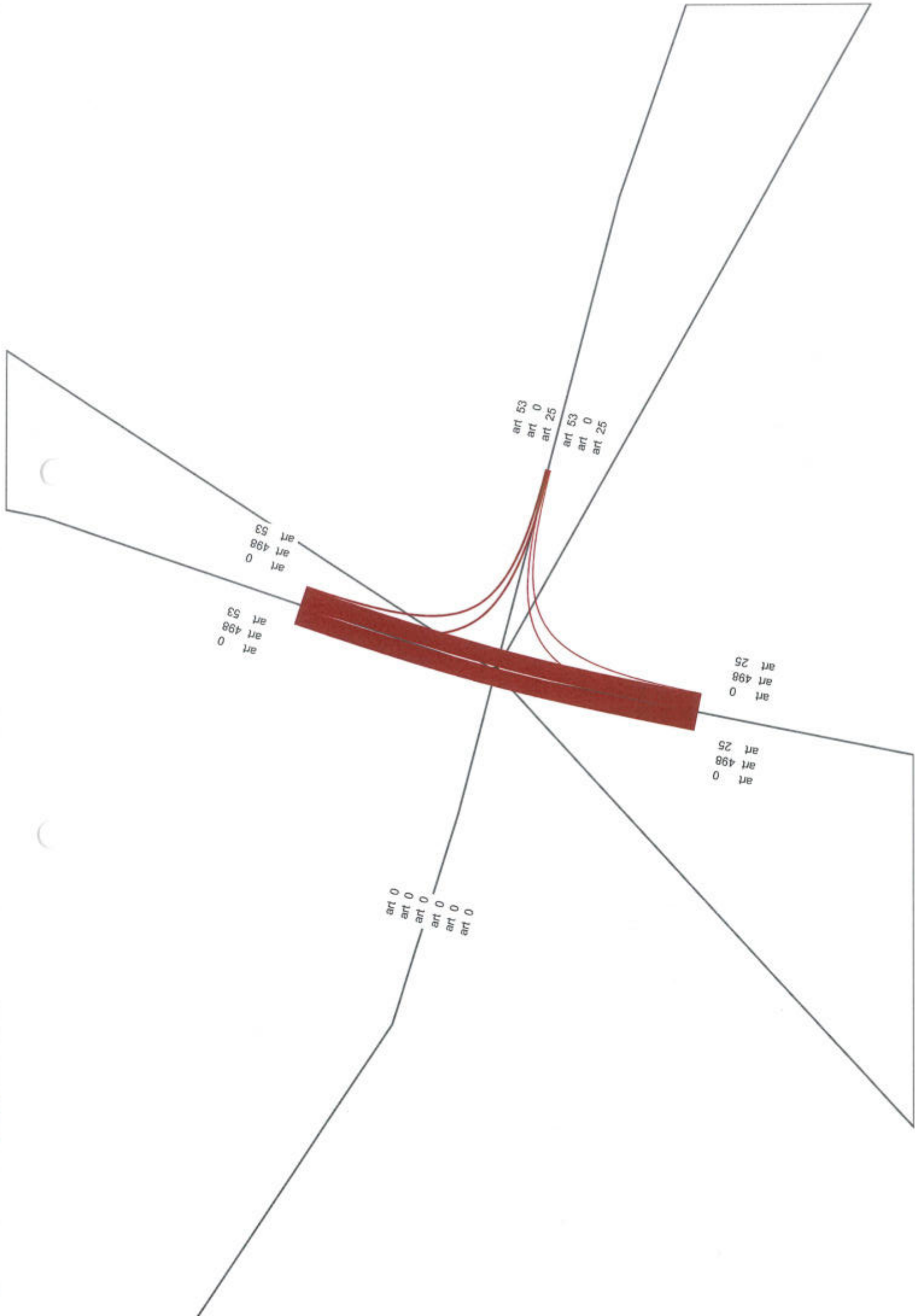
INTERSECTIE VO TIMISOARA SUD – DJ 592

2020

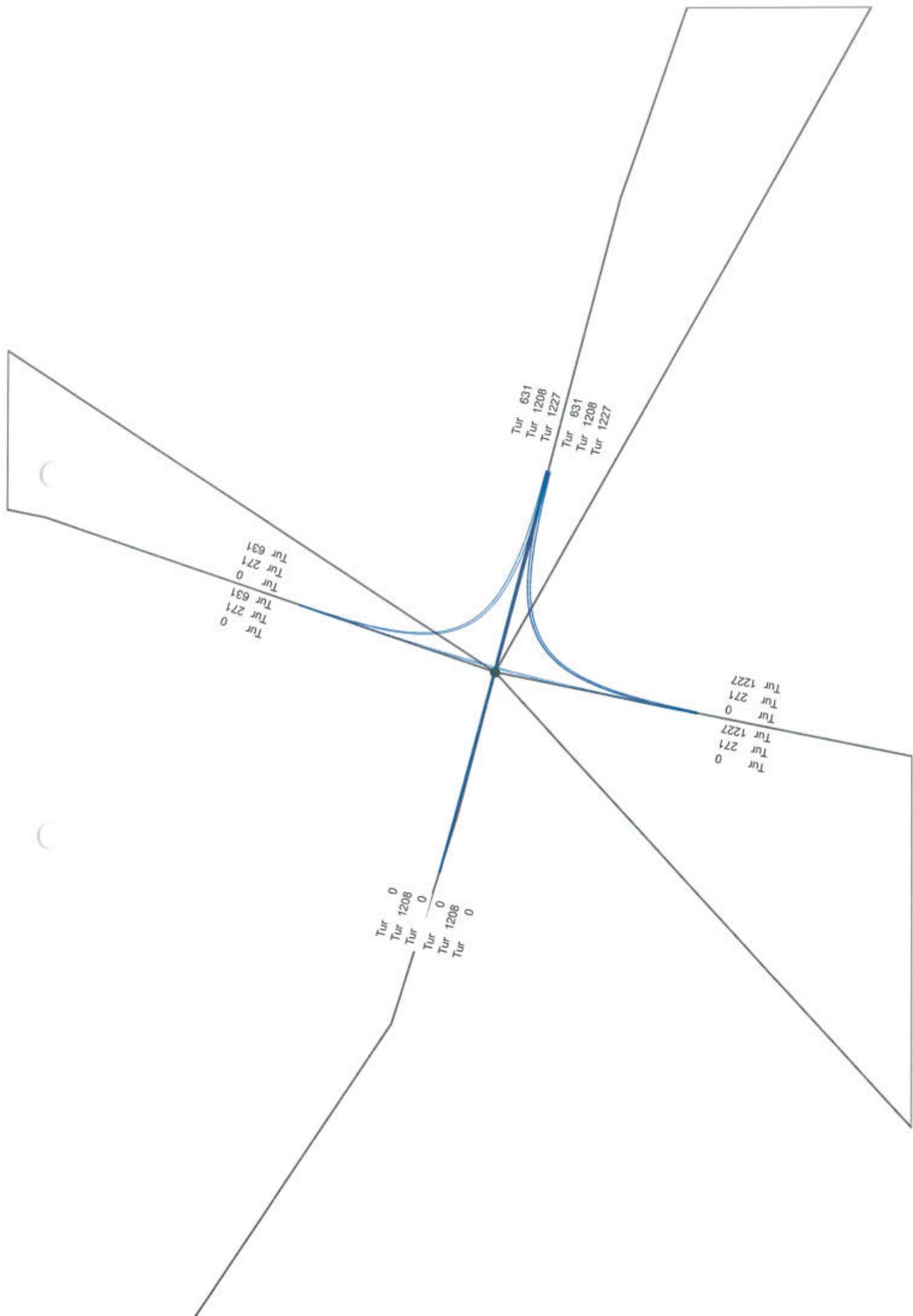


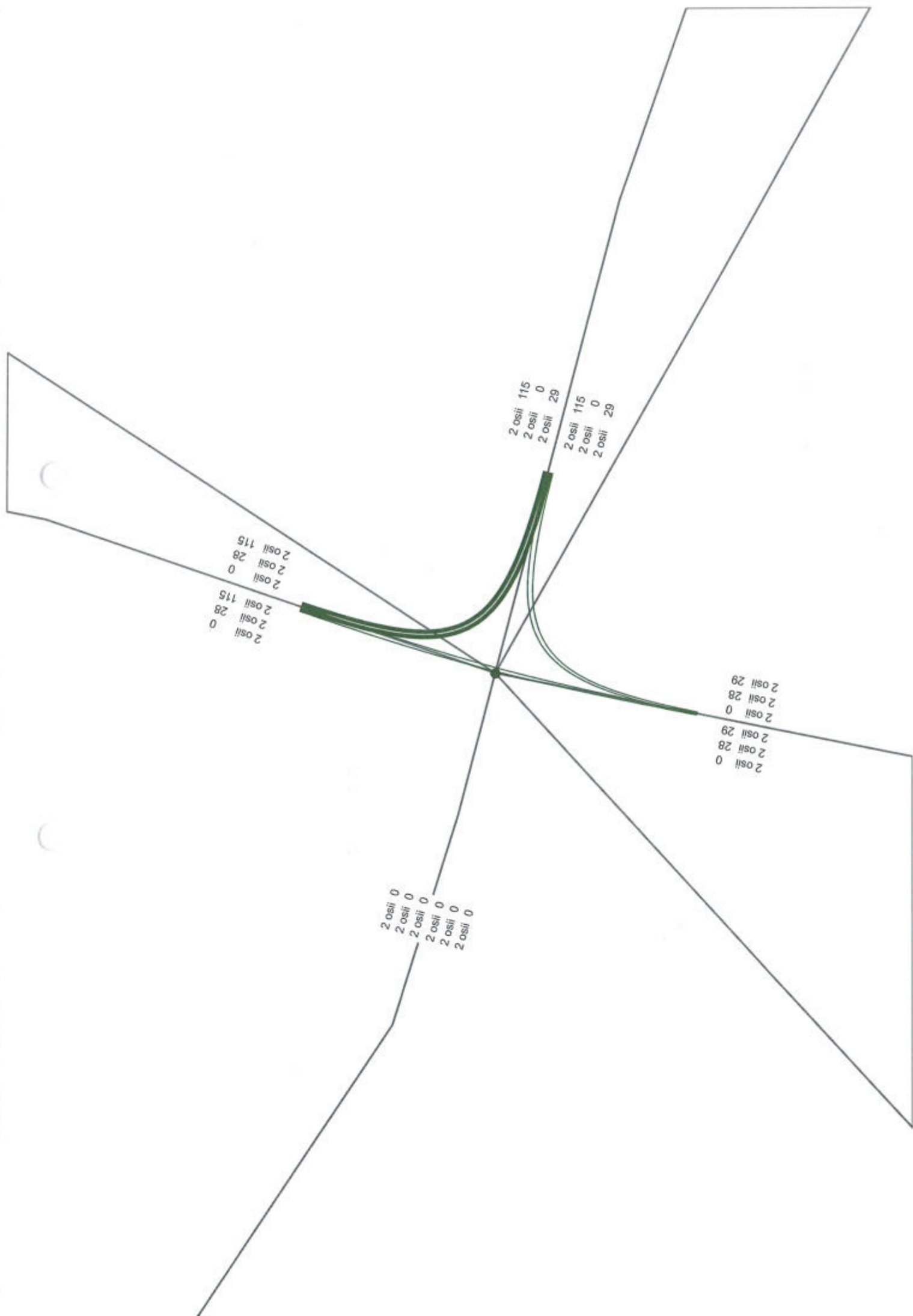


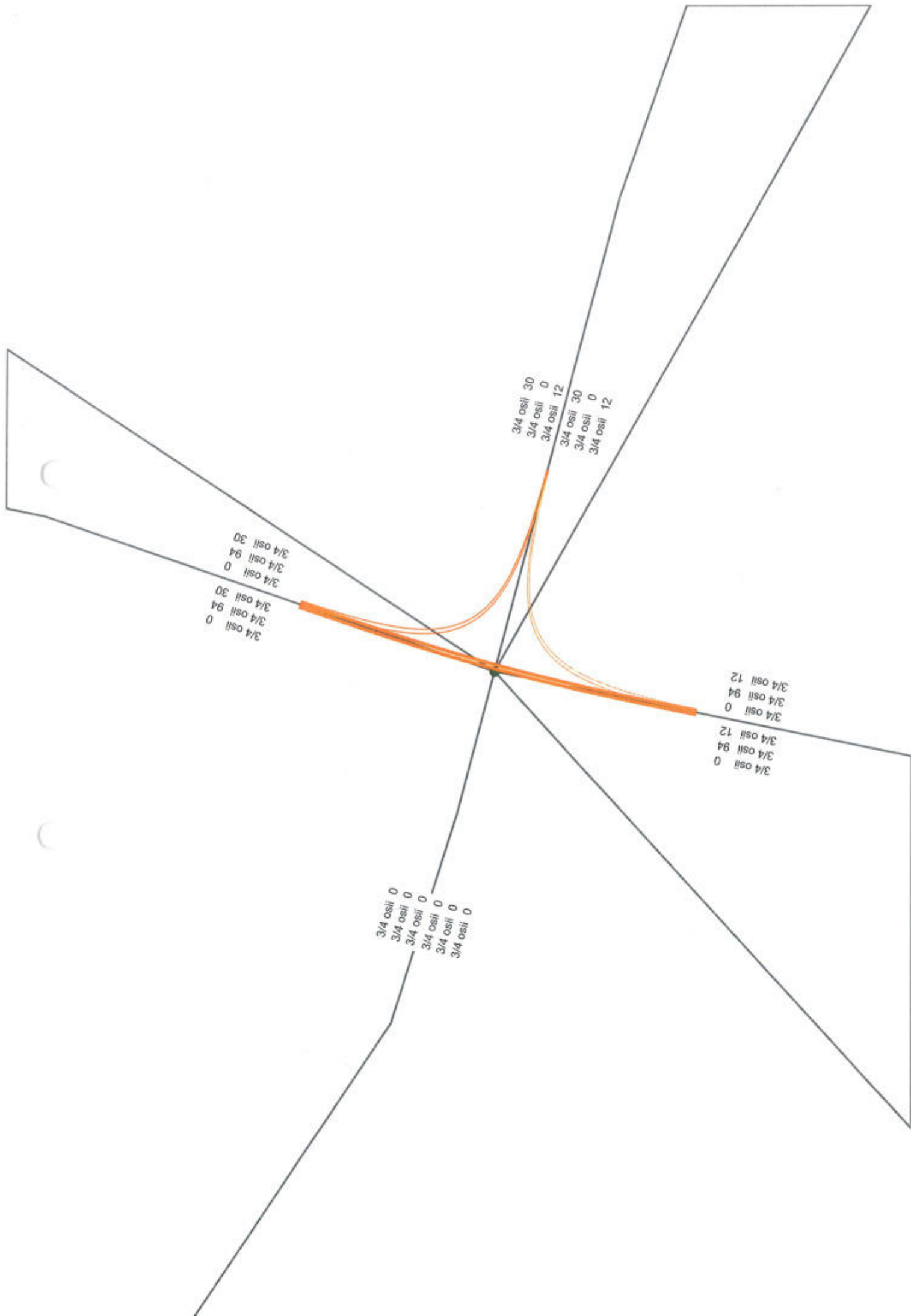


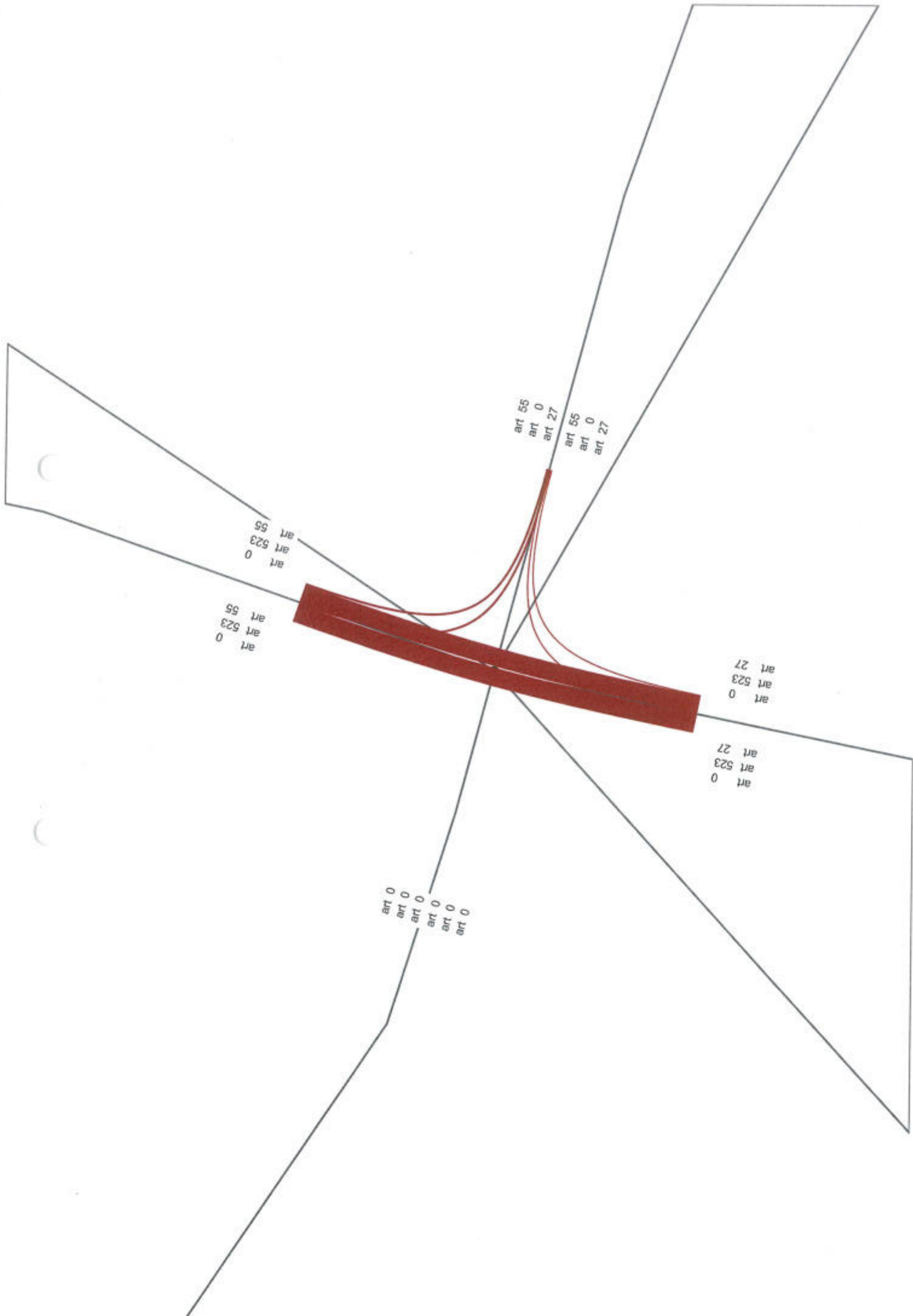


2025









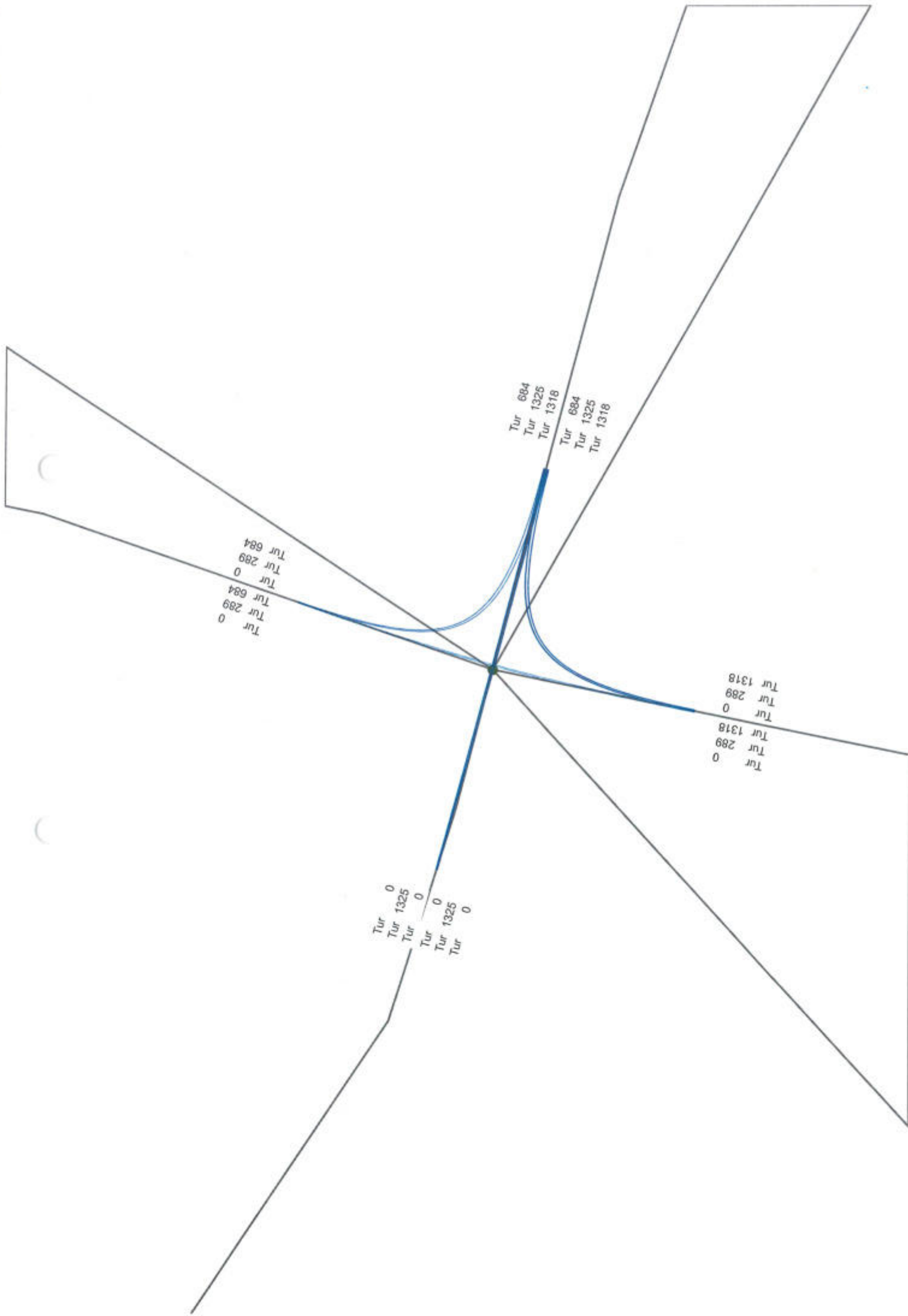
art 0
art 523
art 55

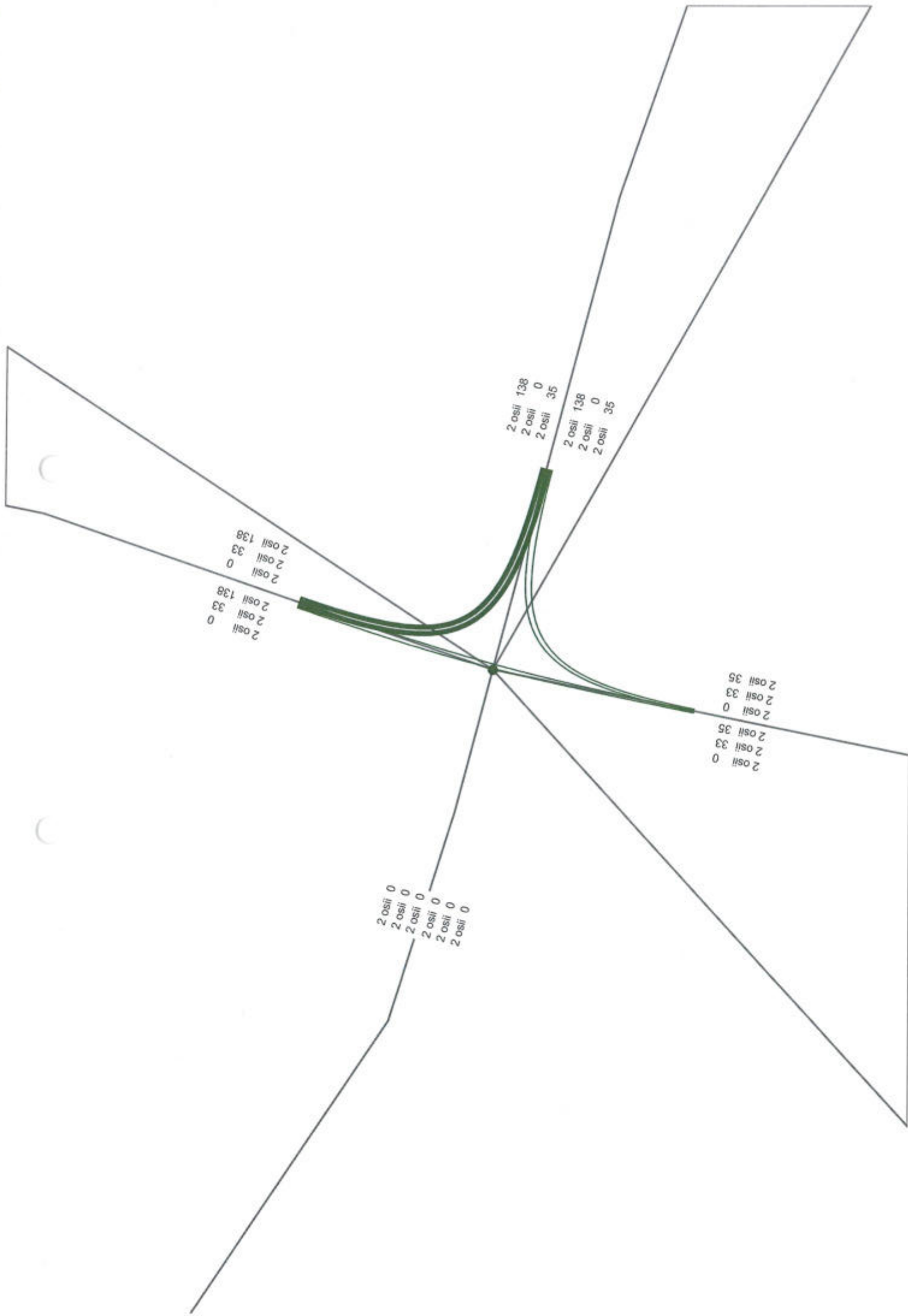
art 55
art 0
art 27

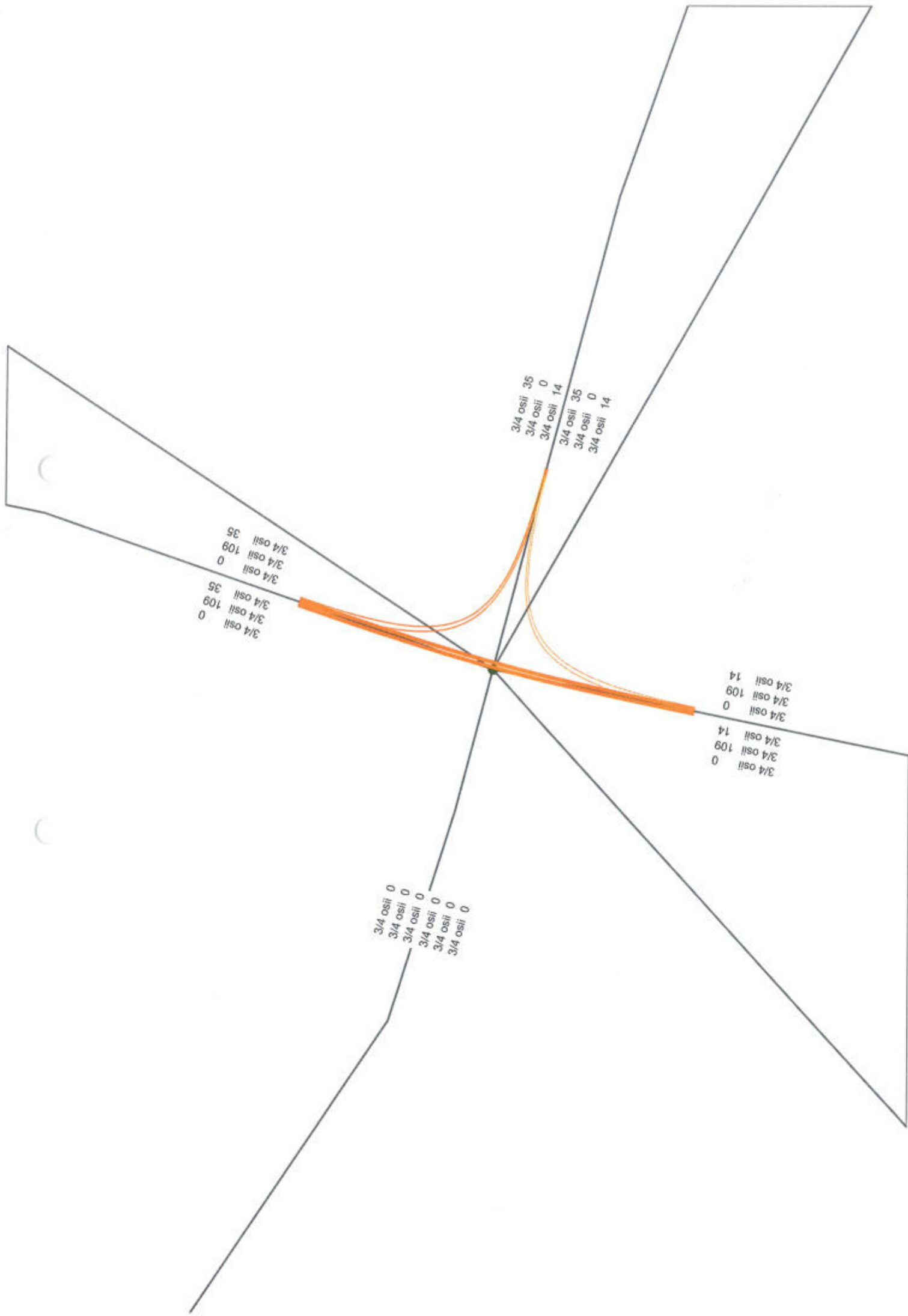
art 0
art 523
art 27

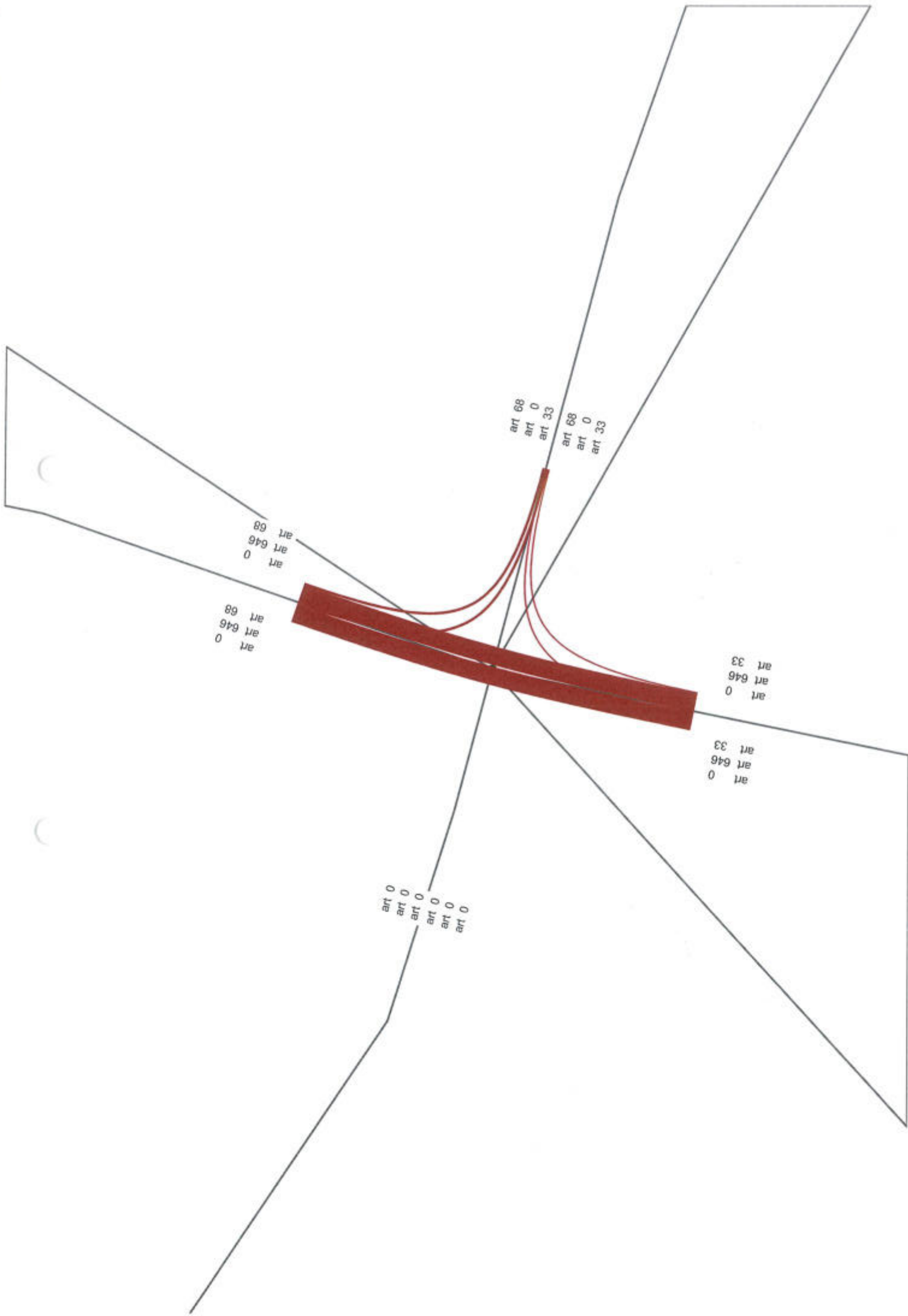
art 0
art 0
art 0
art 0
art 0

2030









art 0
art 646
art 68

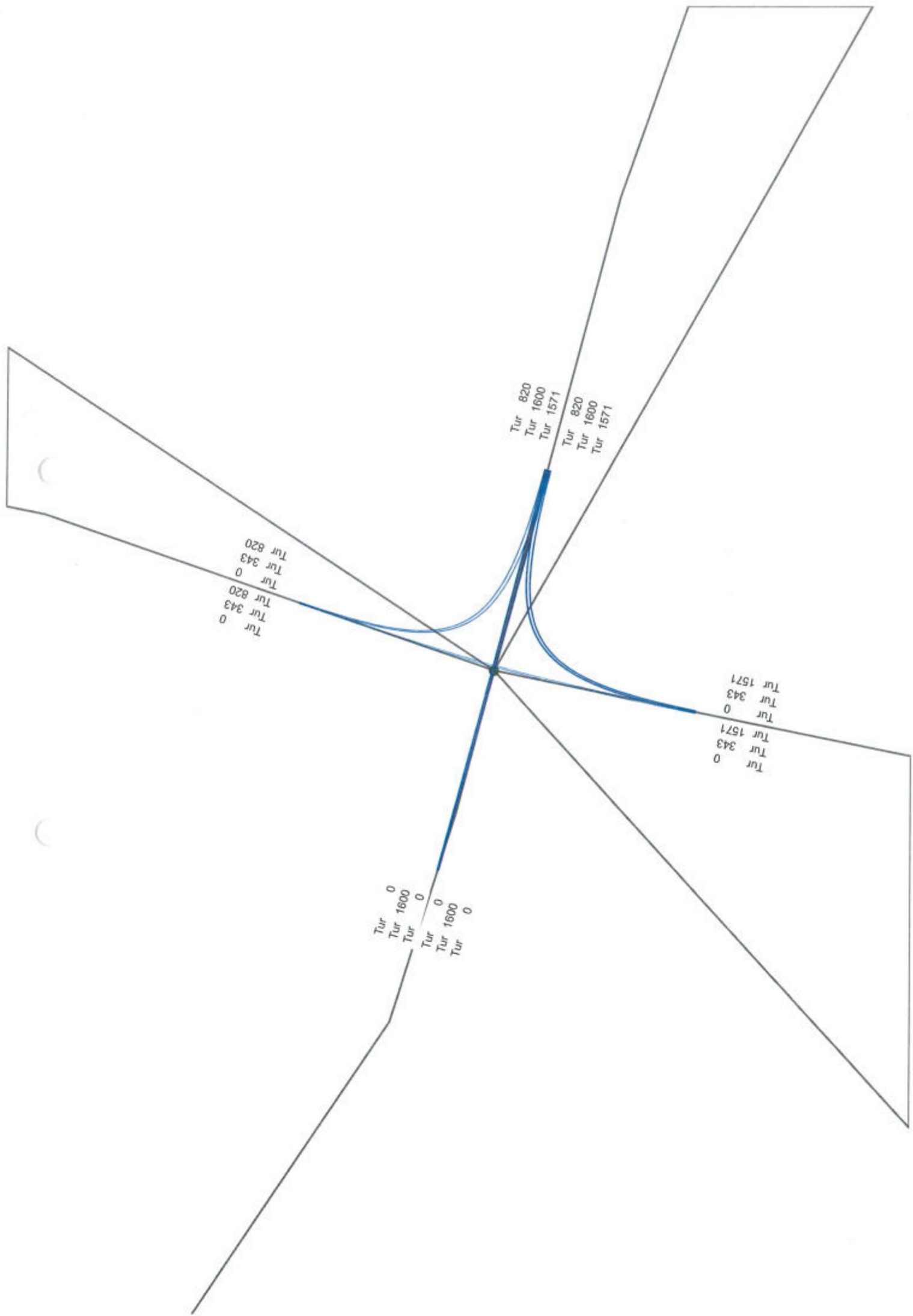
art 68
art 0
art 33

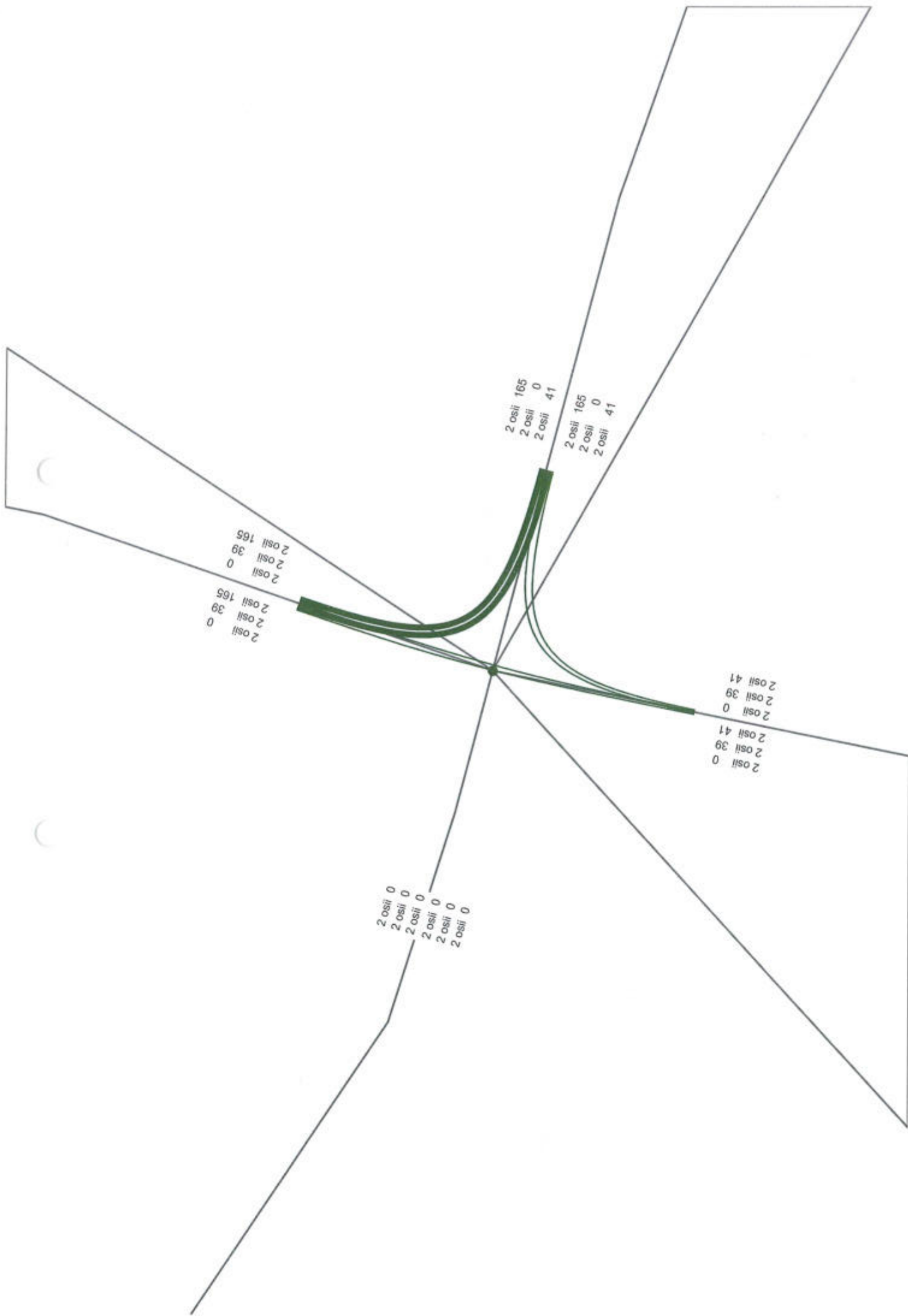
art 68
art 0
art 33

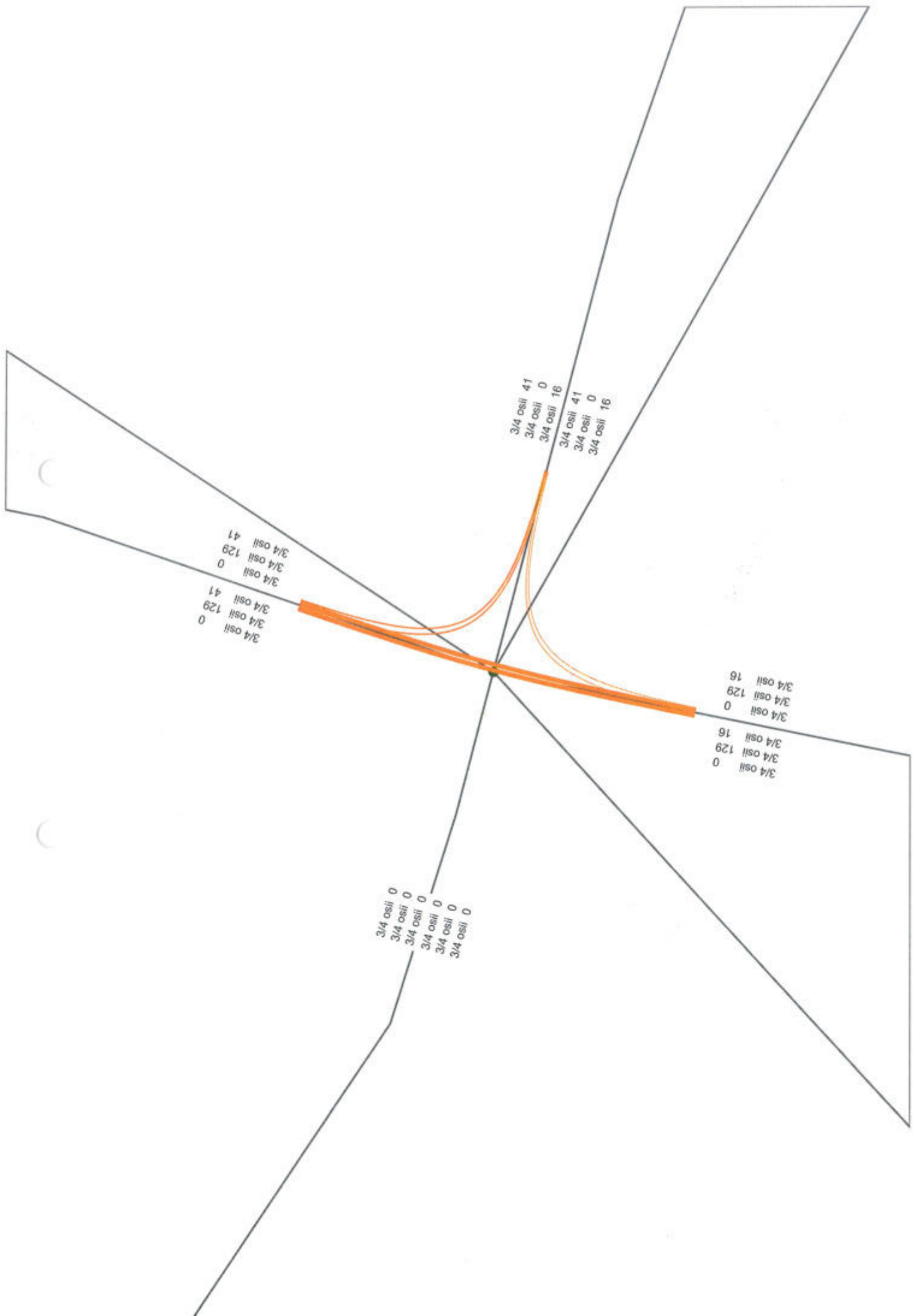
art 0
art 646
art 33

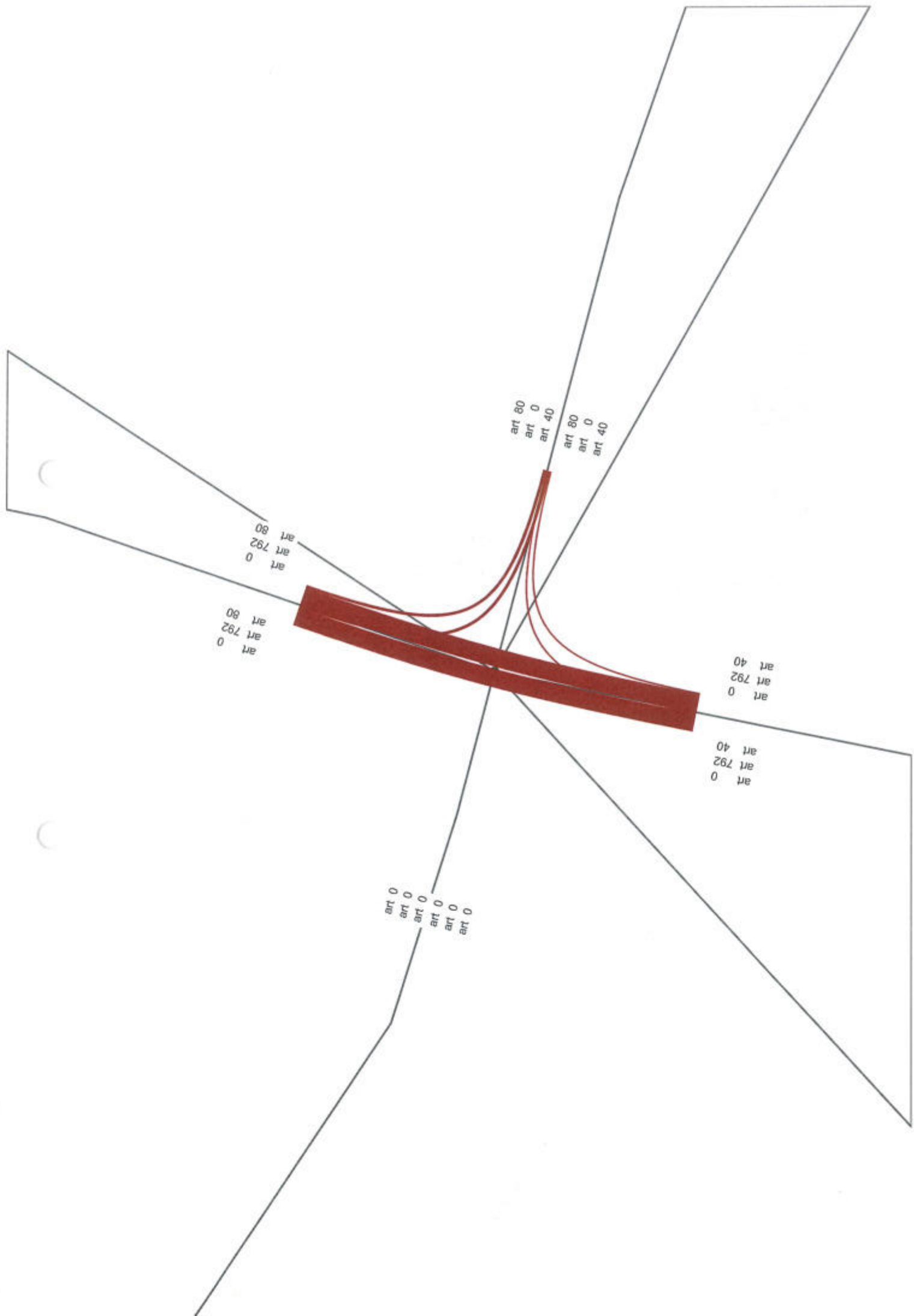
art 0
art 0
art 0
art 0
art 0

2035

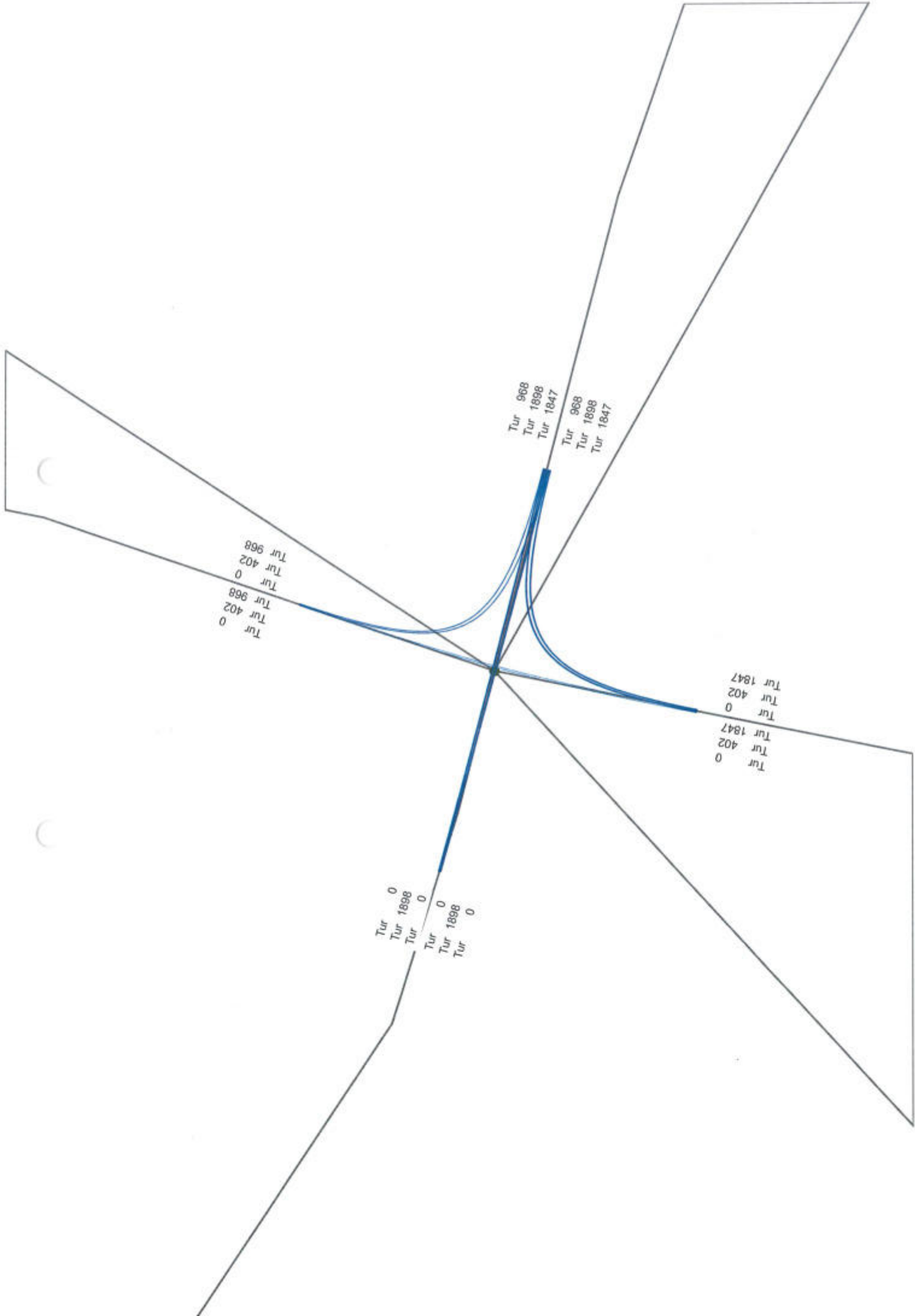


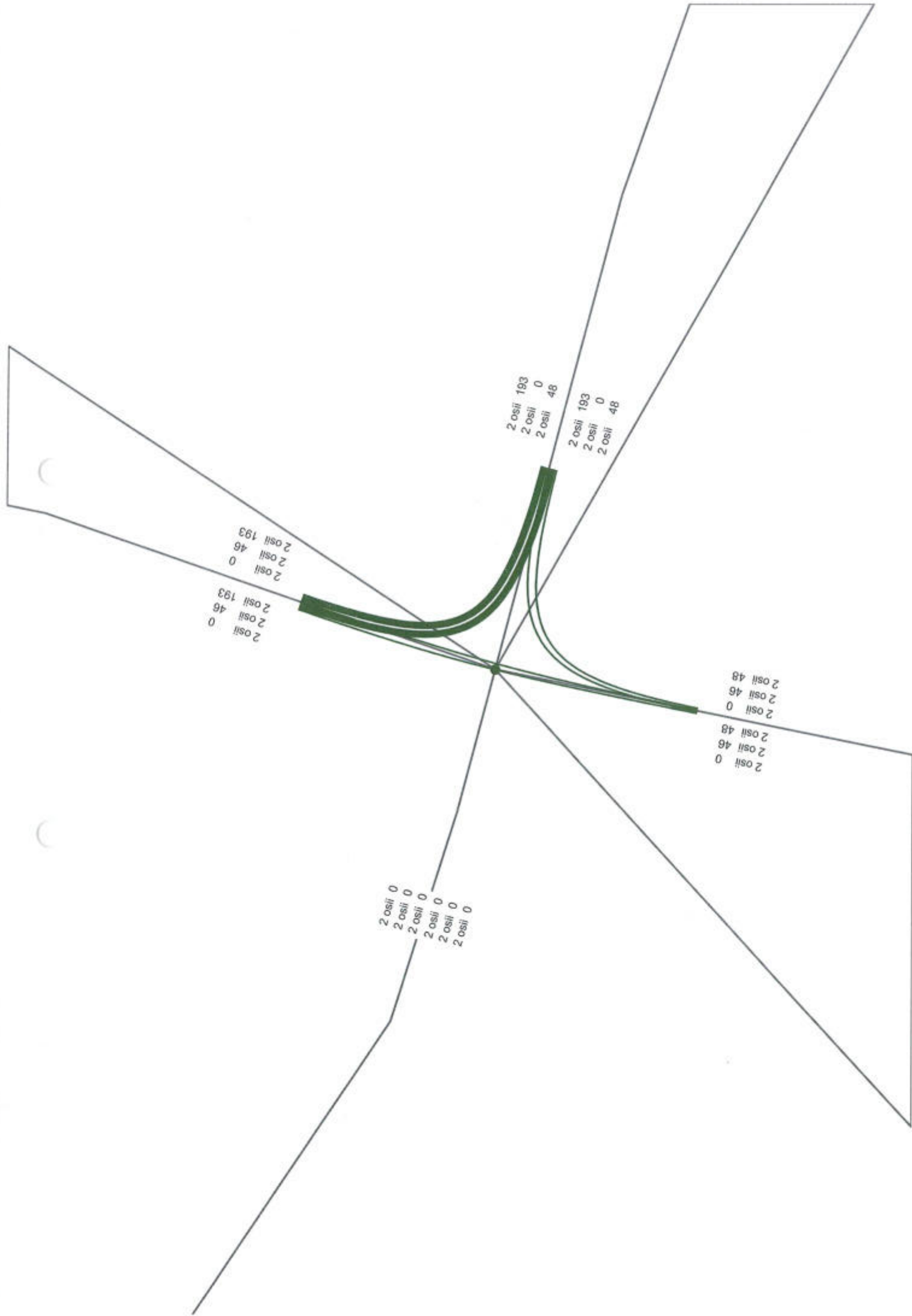


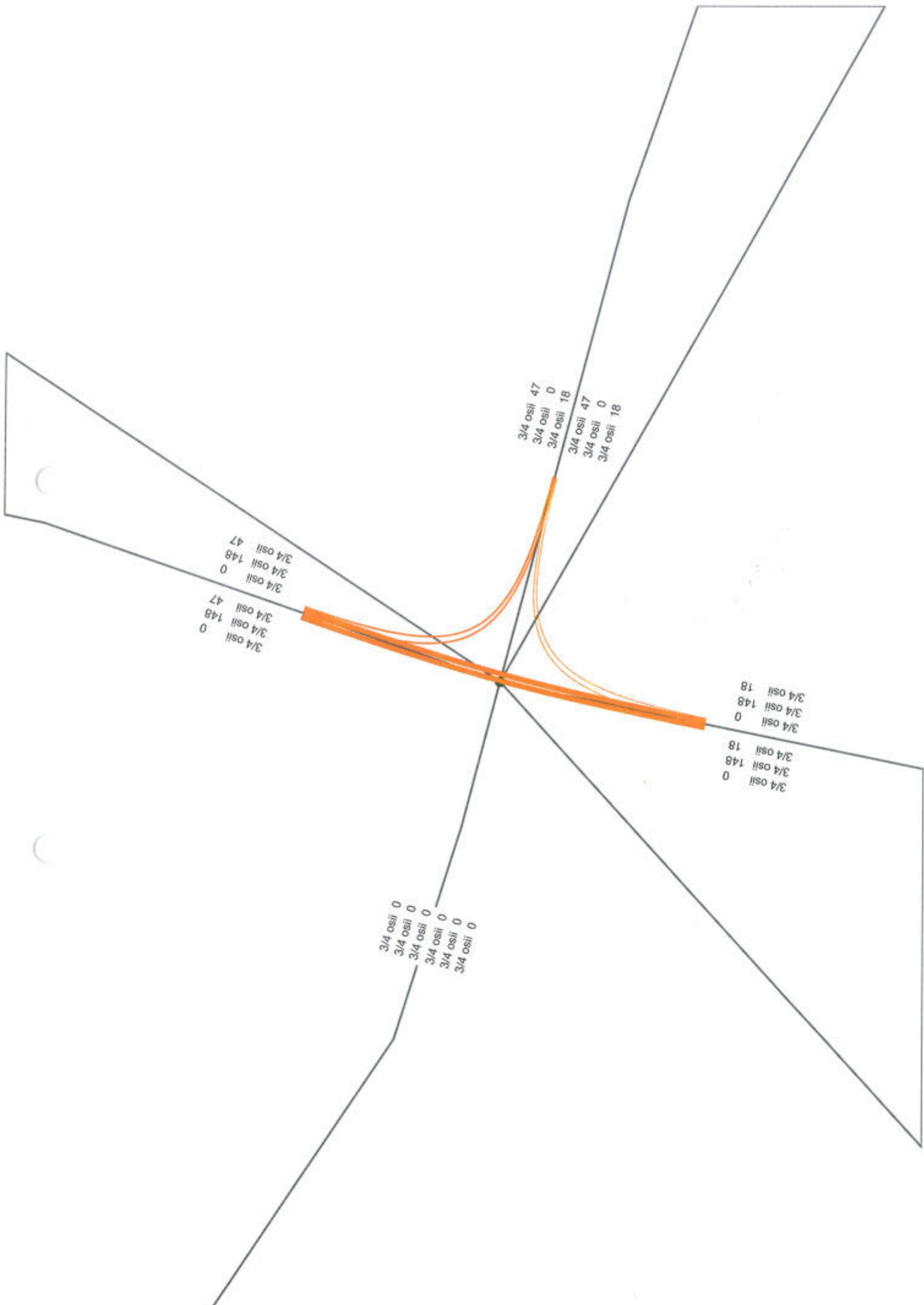




2040





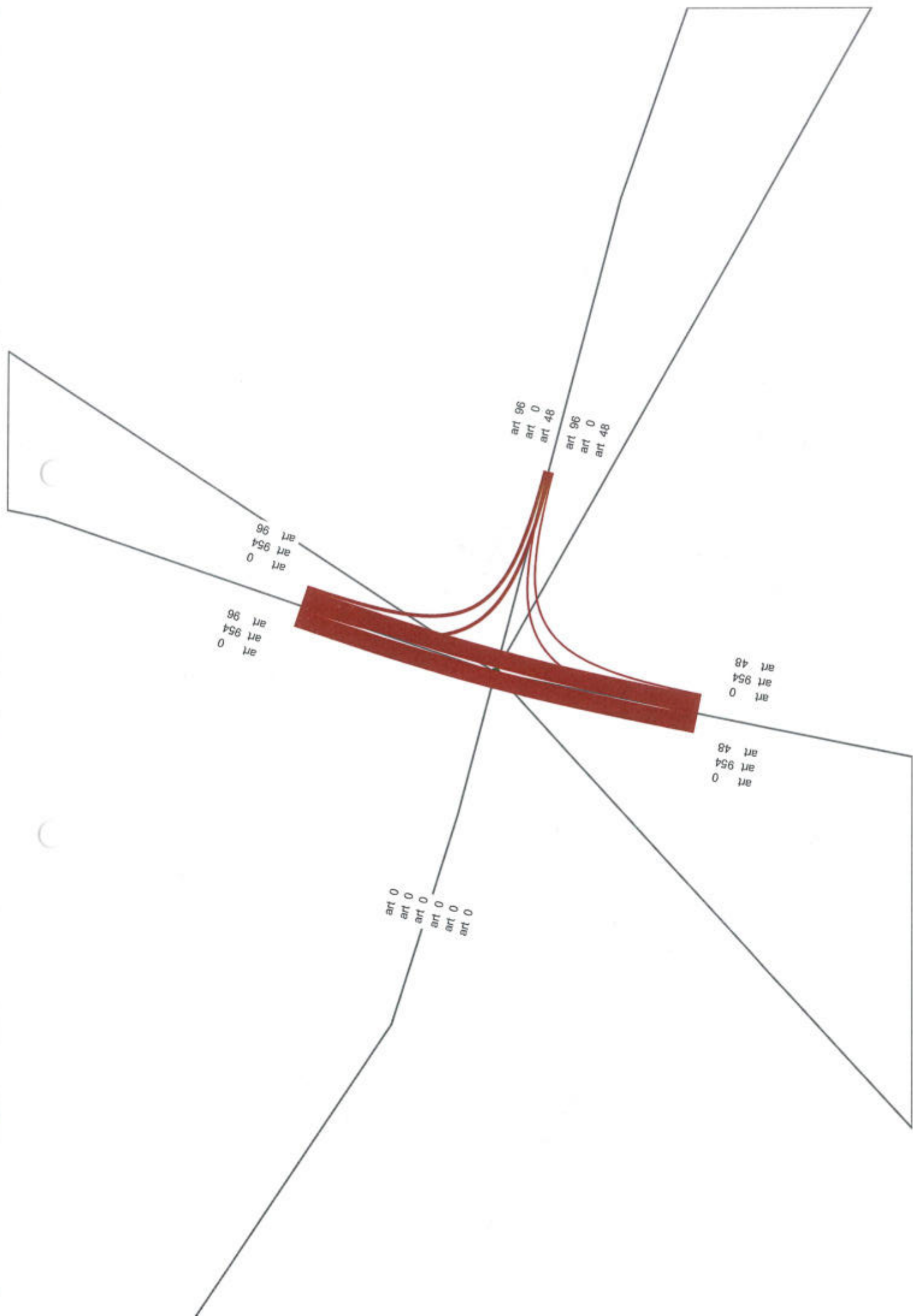


3/4 osil 0
3/4 osil 47
3/4 osil 148

3/4 osil 18
3/4 osil 47
3/4 osil 0

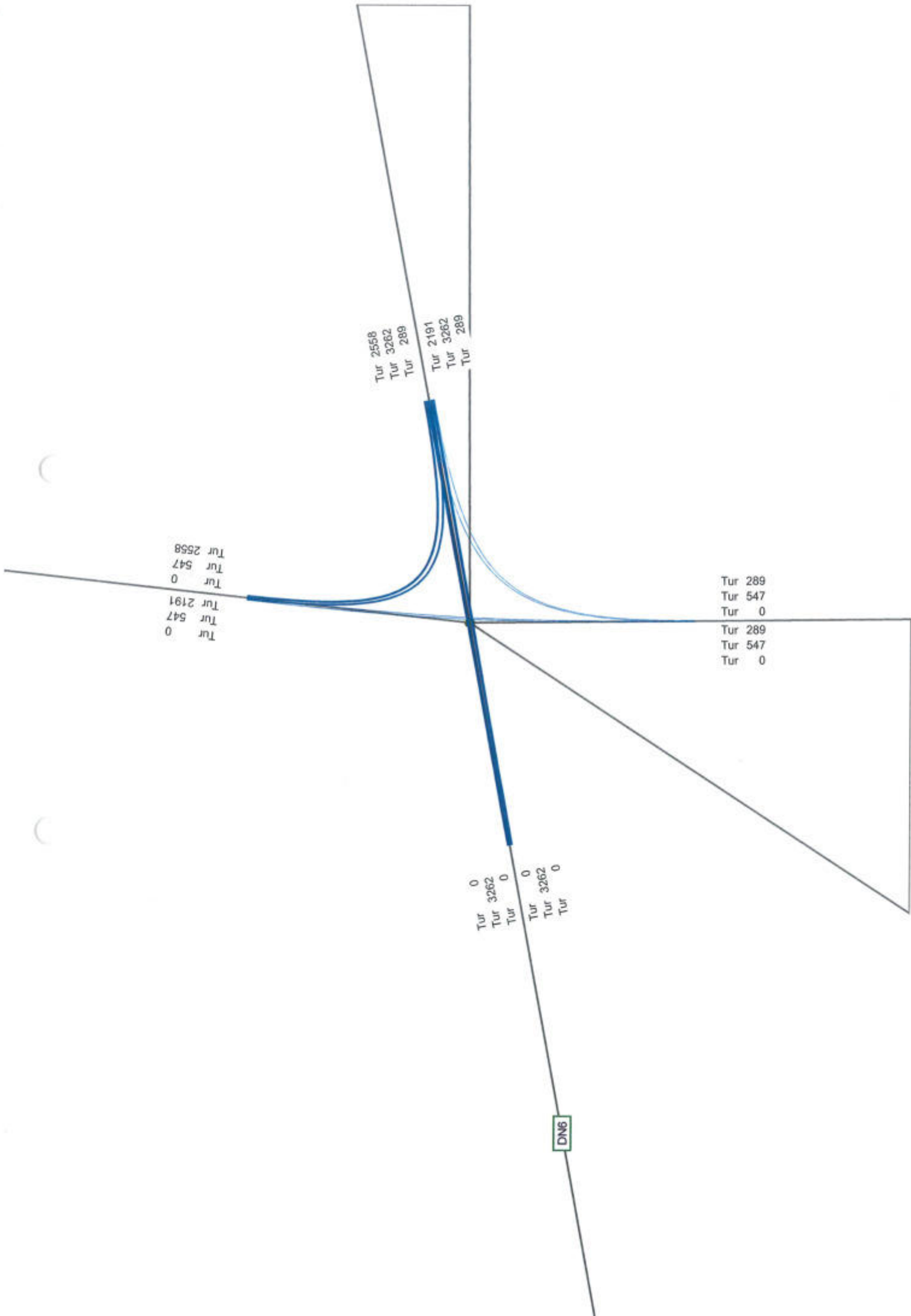
3/4 osil 0
3/4 osil 148
3/4 osil 18

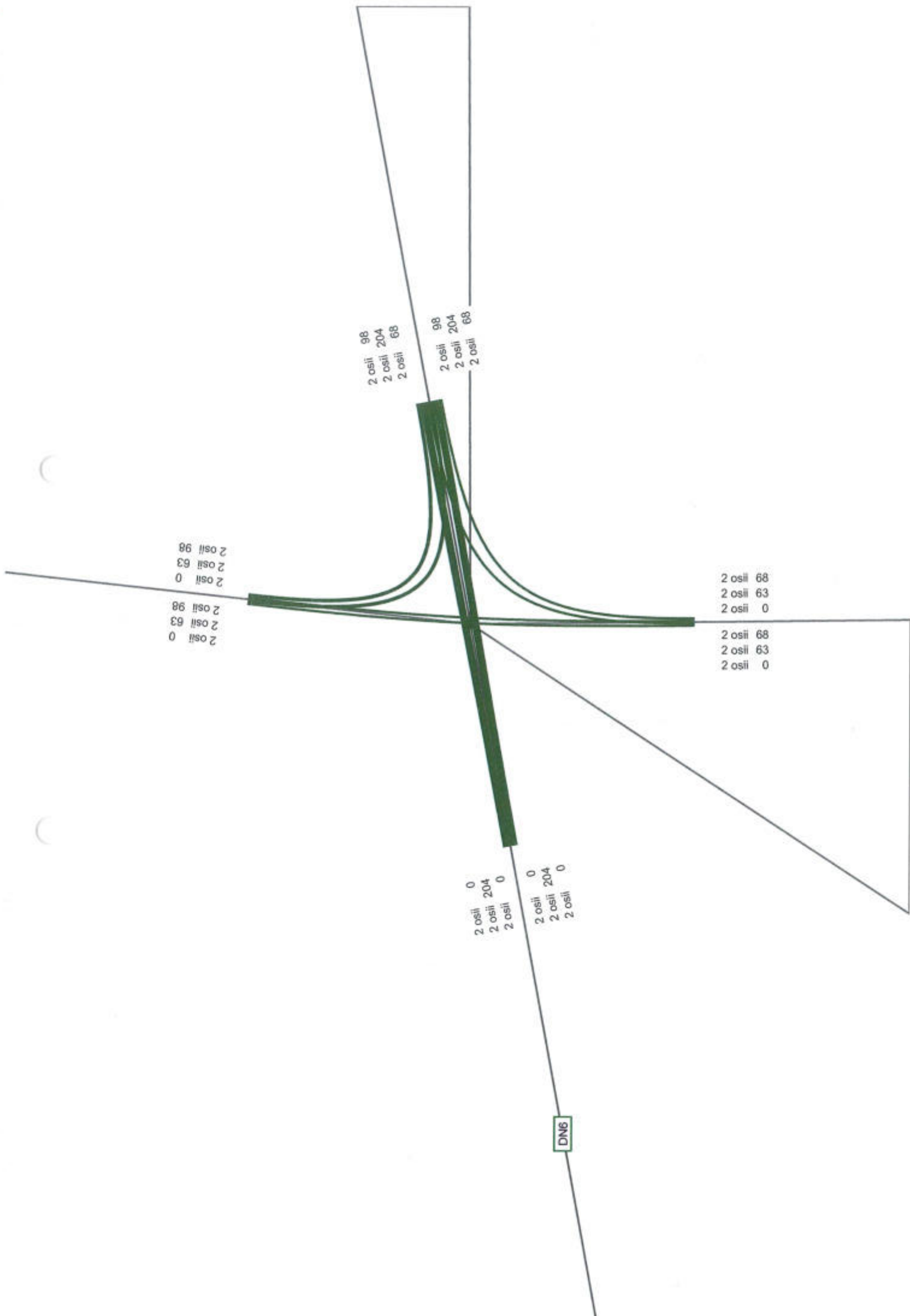
3/4 osil 0
3/4 osil 0
3/4 osil 0
3/4 osil 0
3/4 osil 0
3/4 osil 0

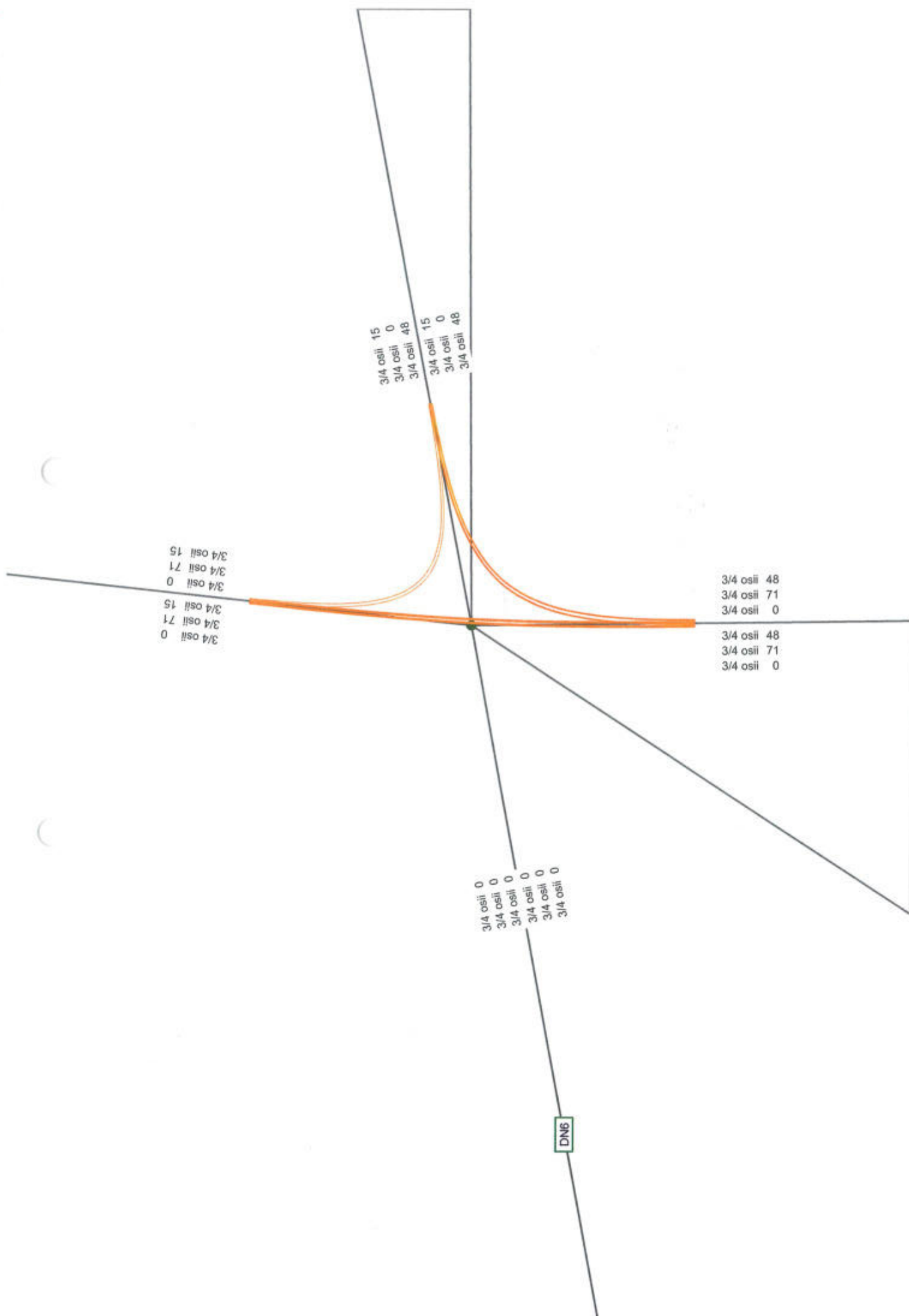


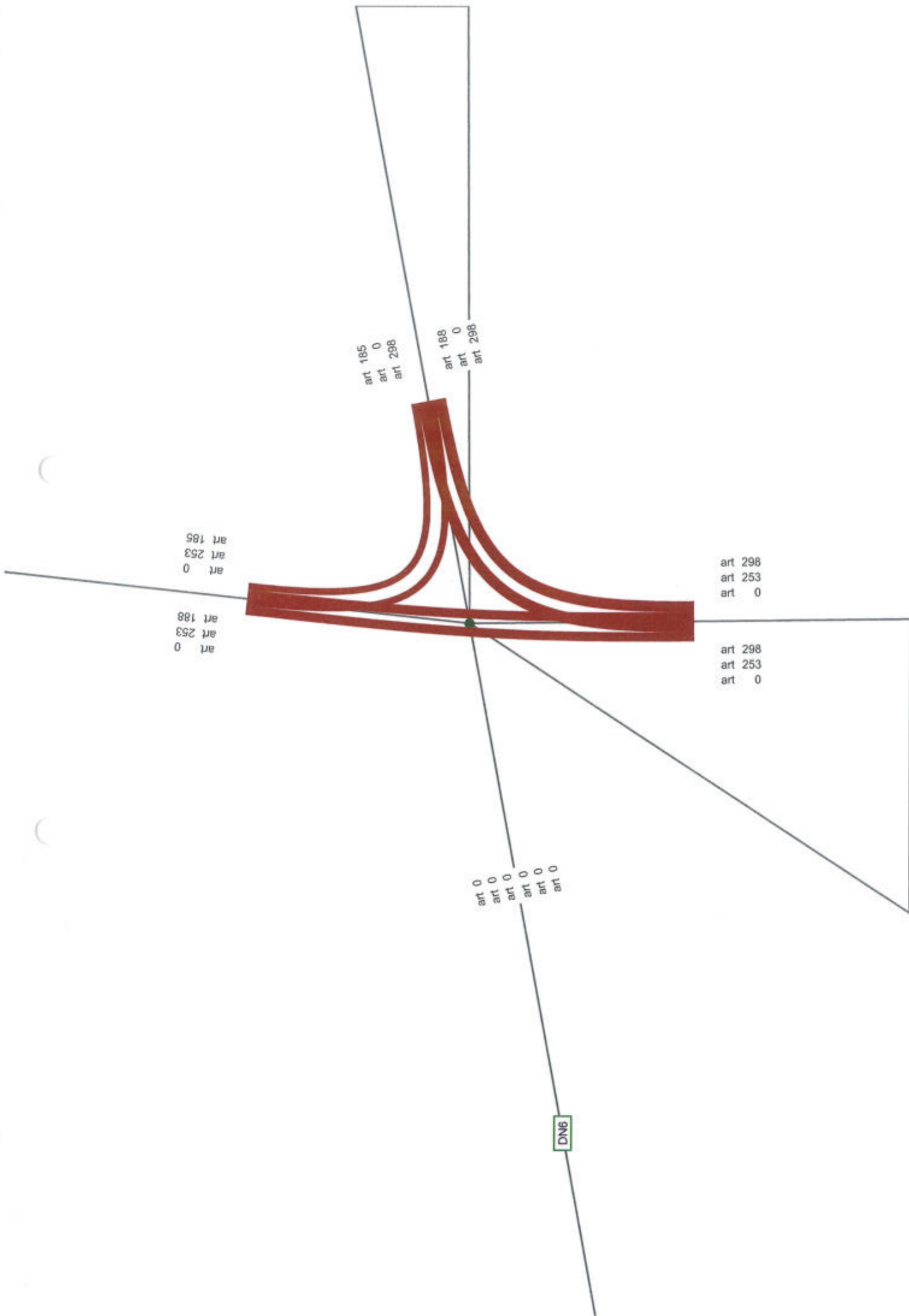
INTERSECTIE VO TIMISOARA SUD – DN 6

2020

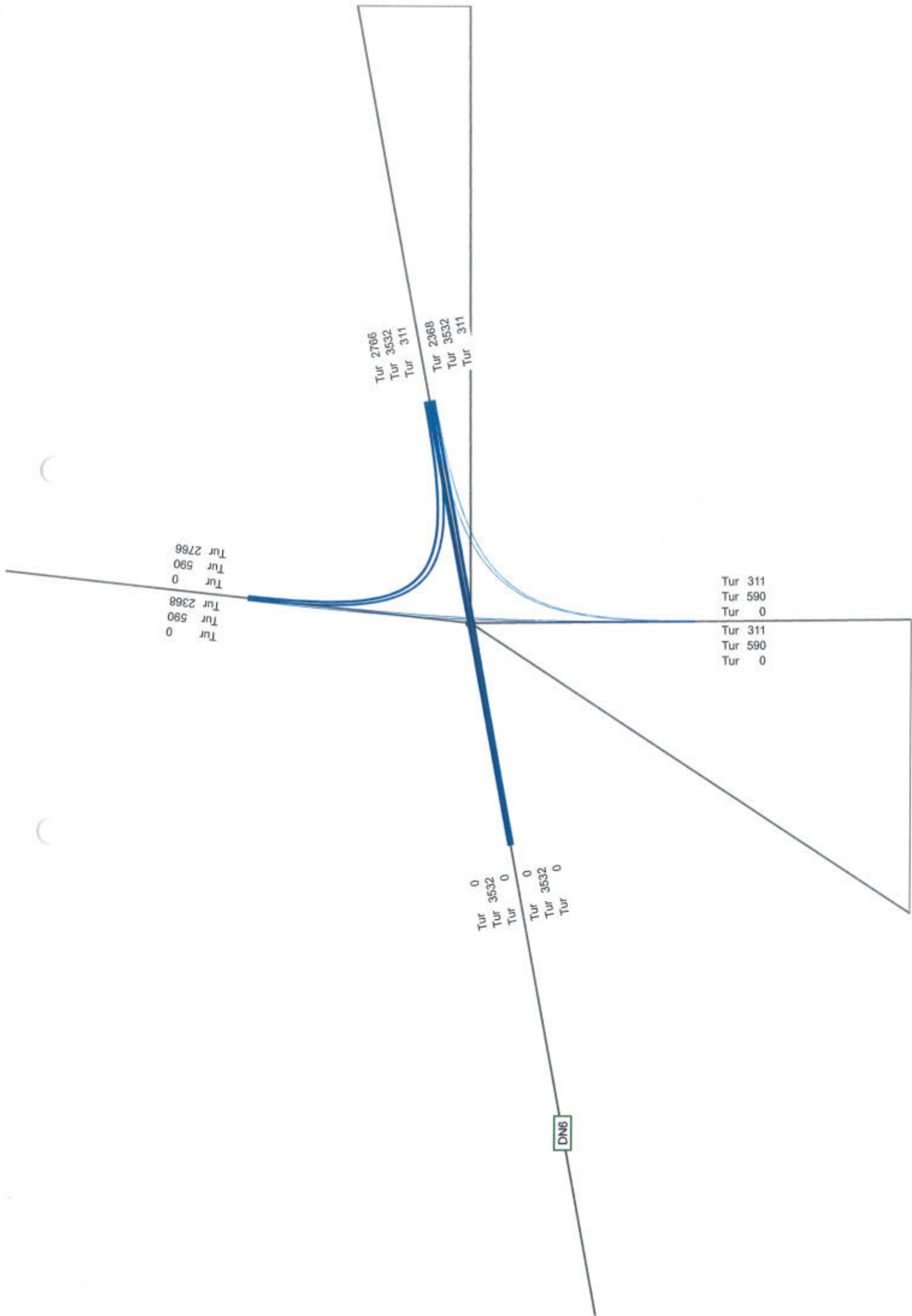


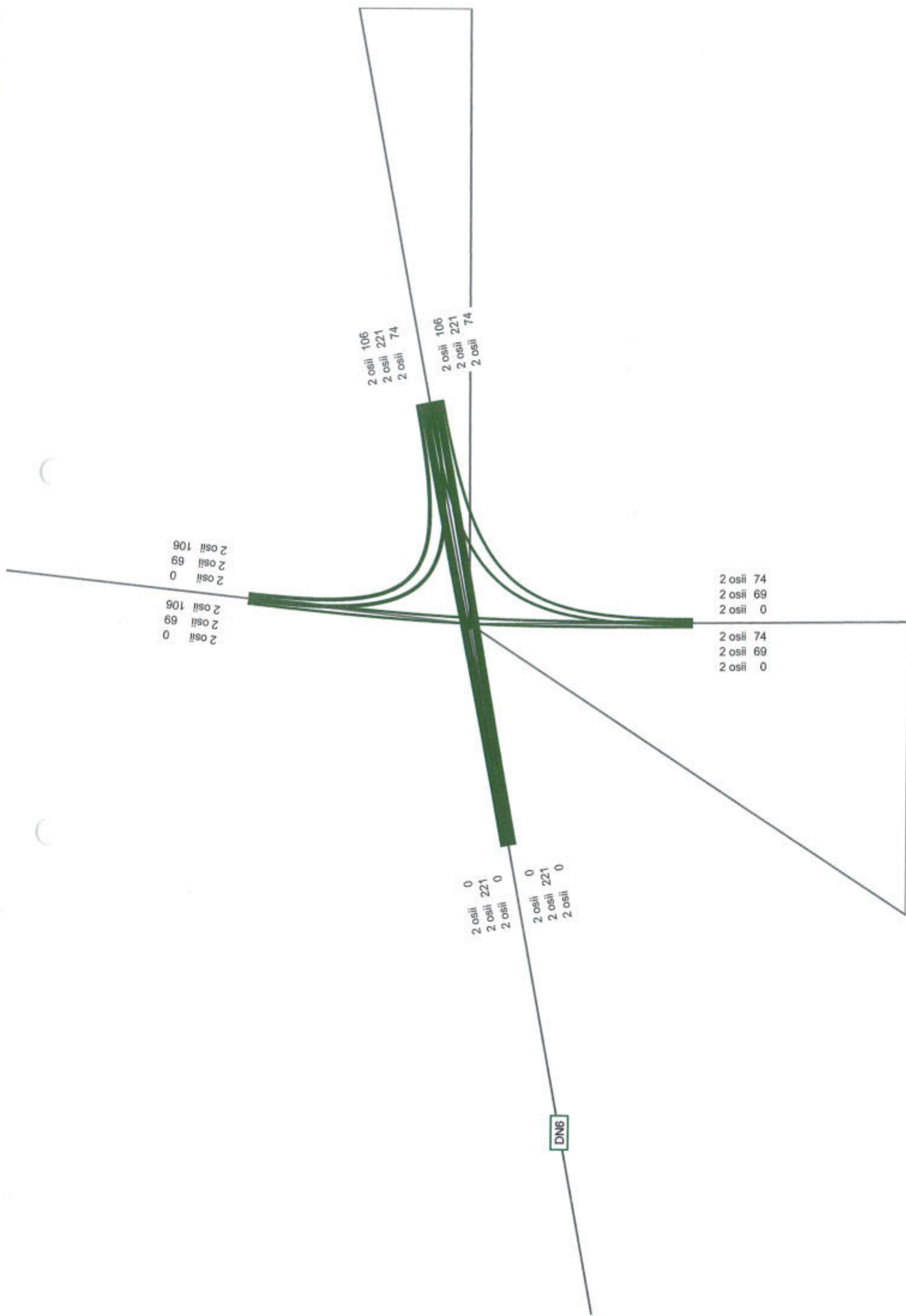


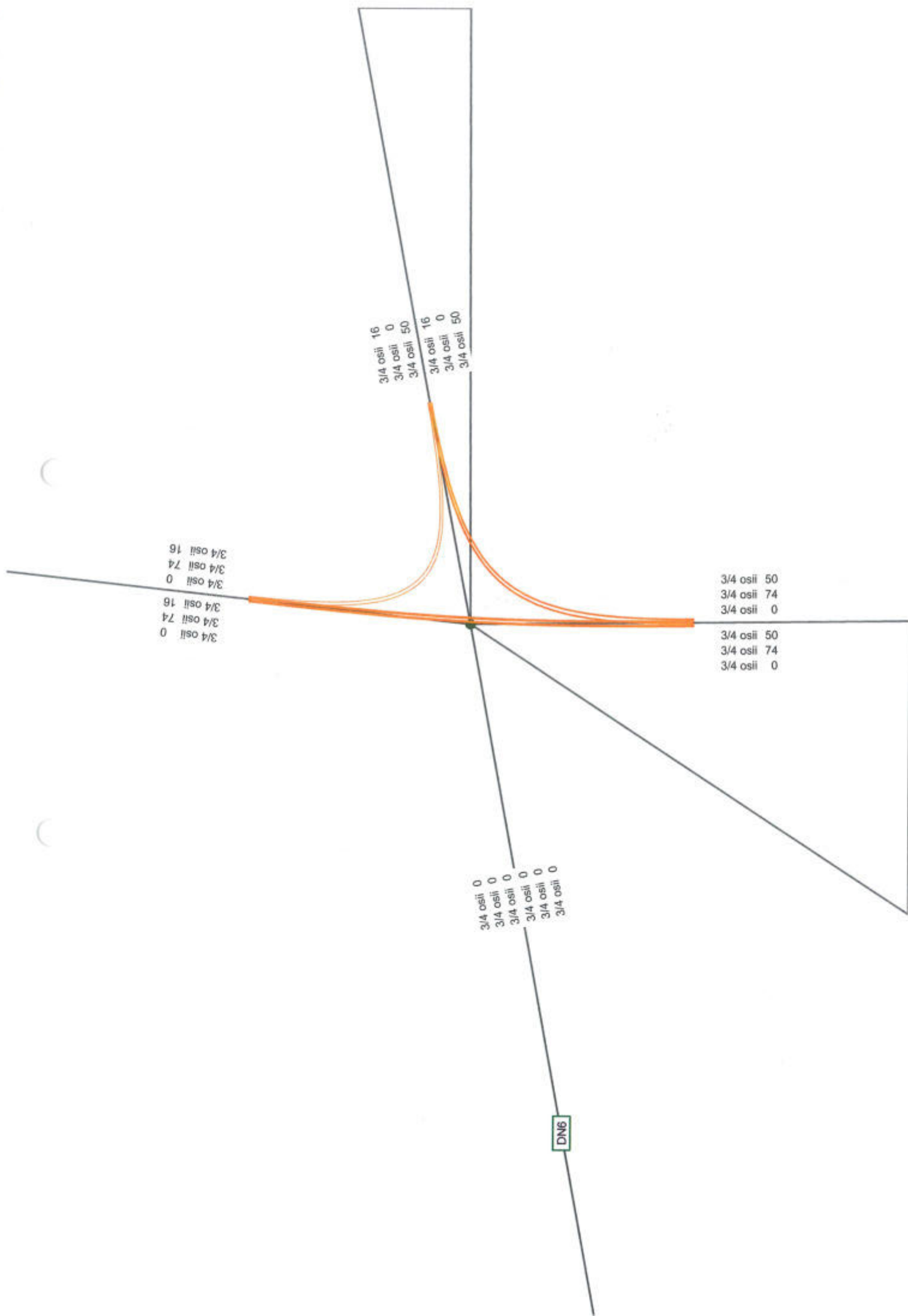


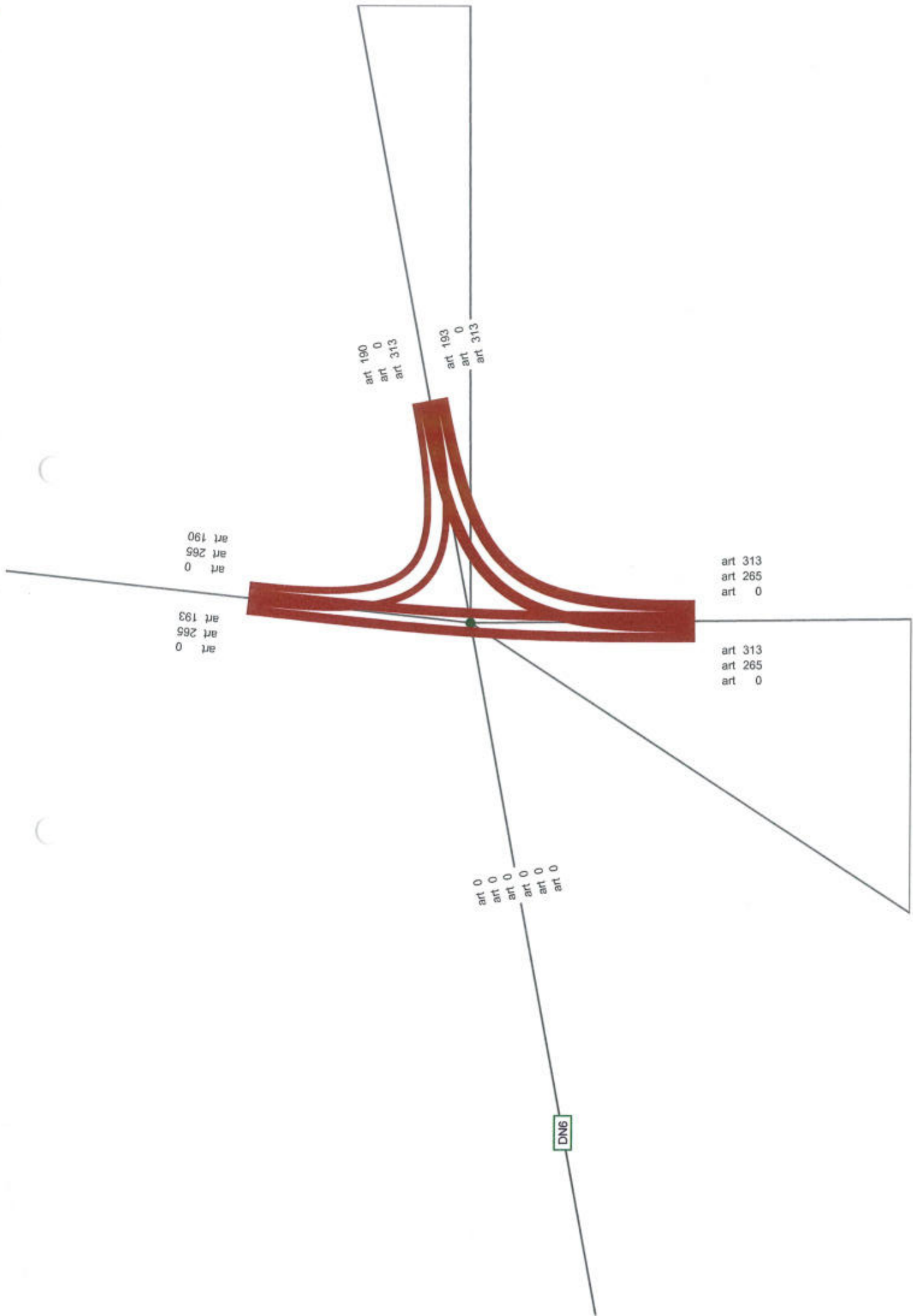


2025

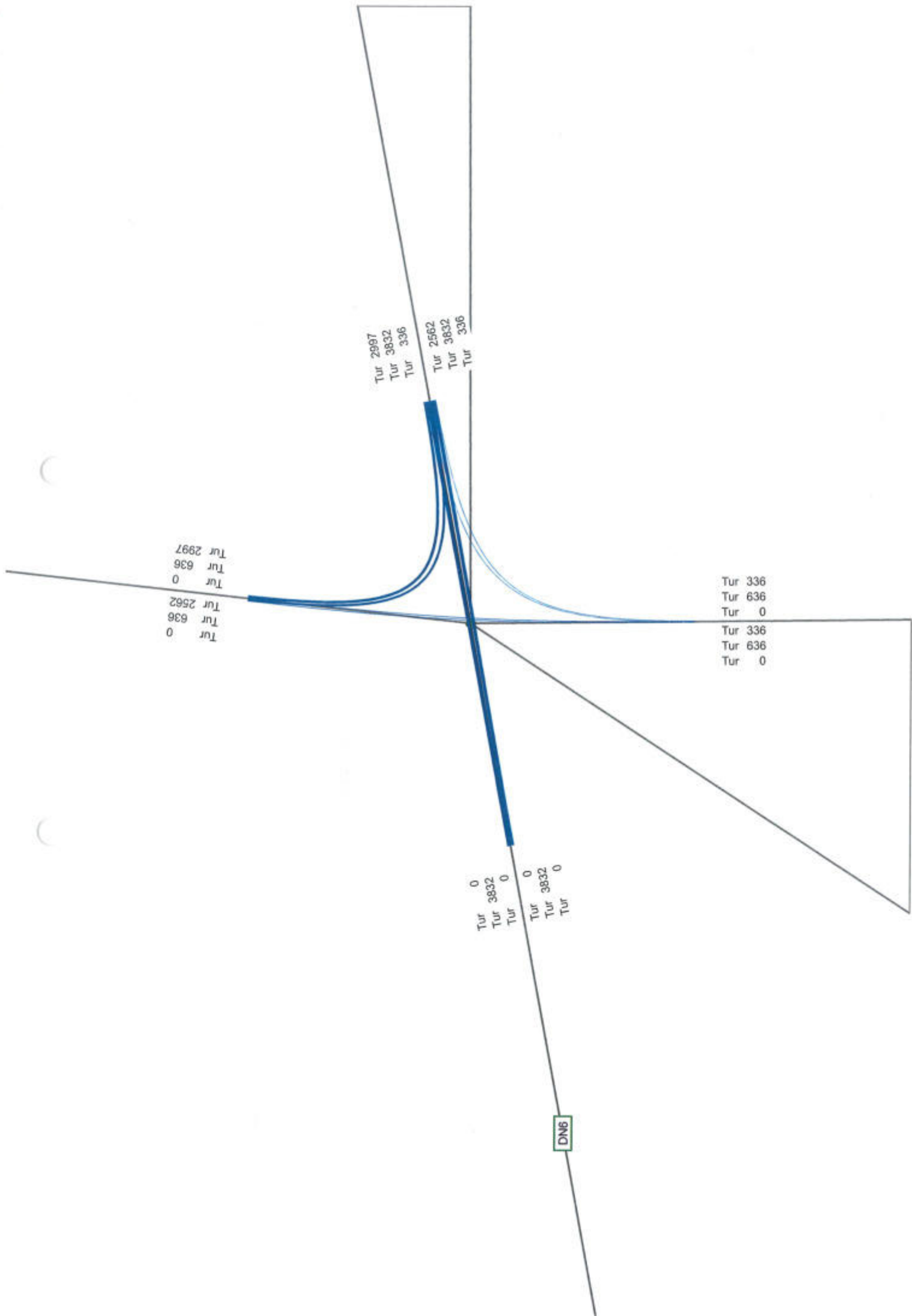


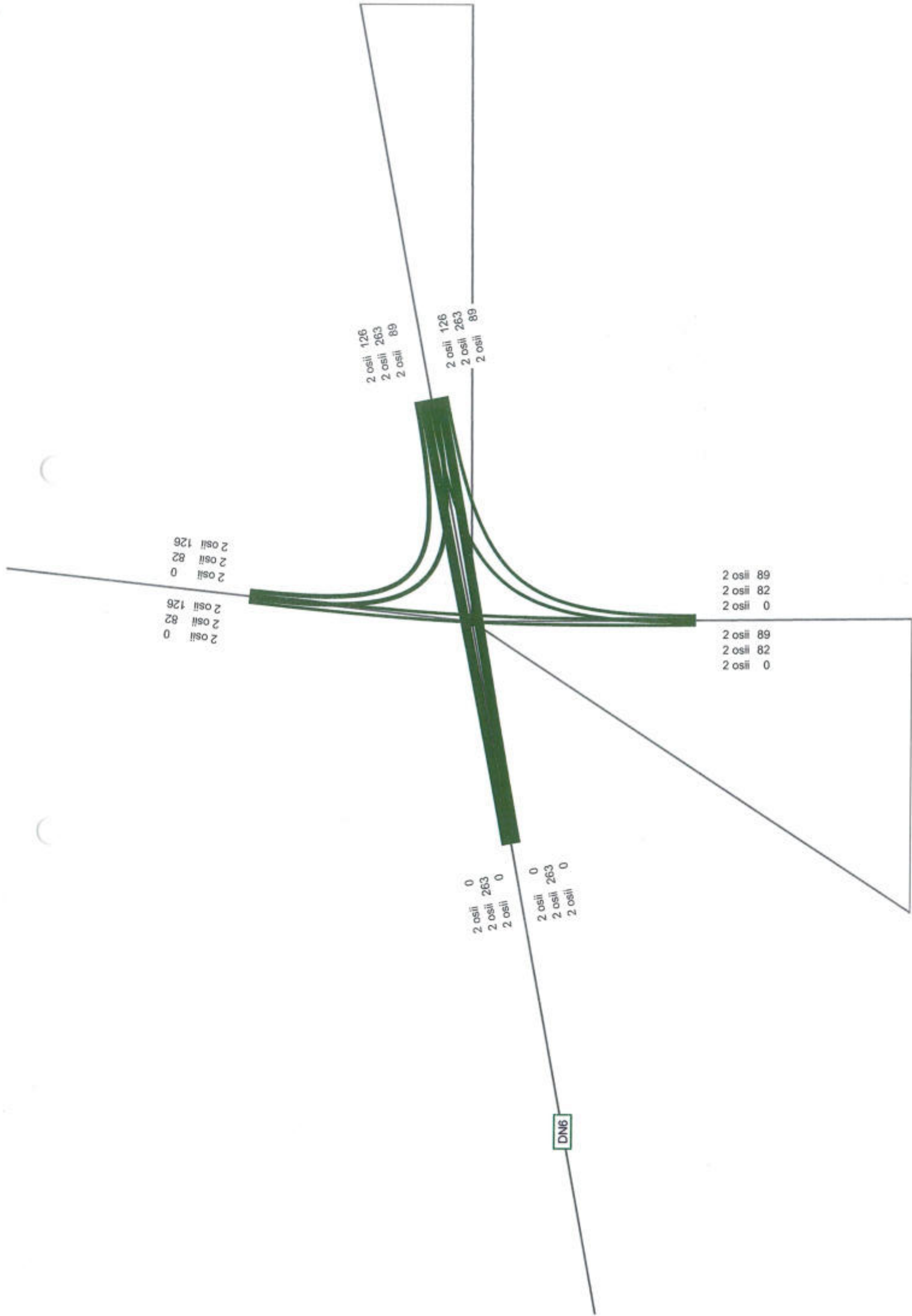


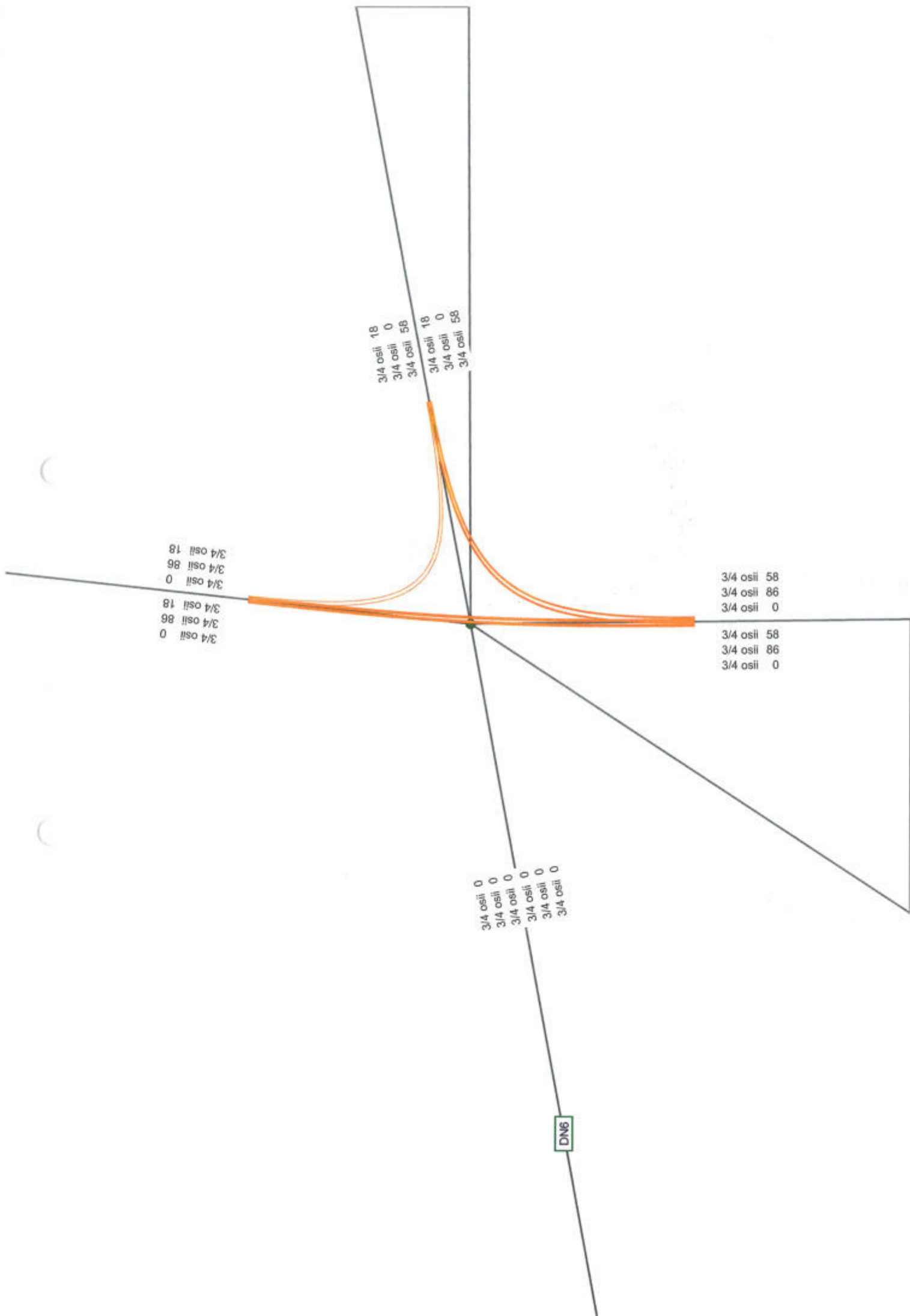


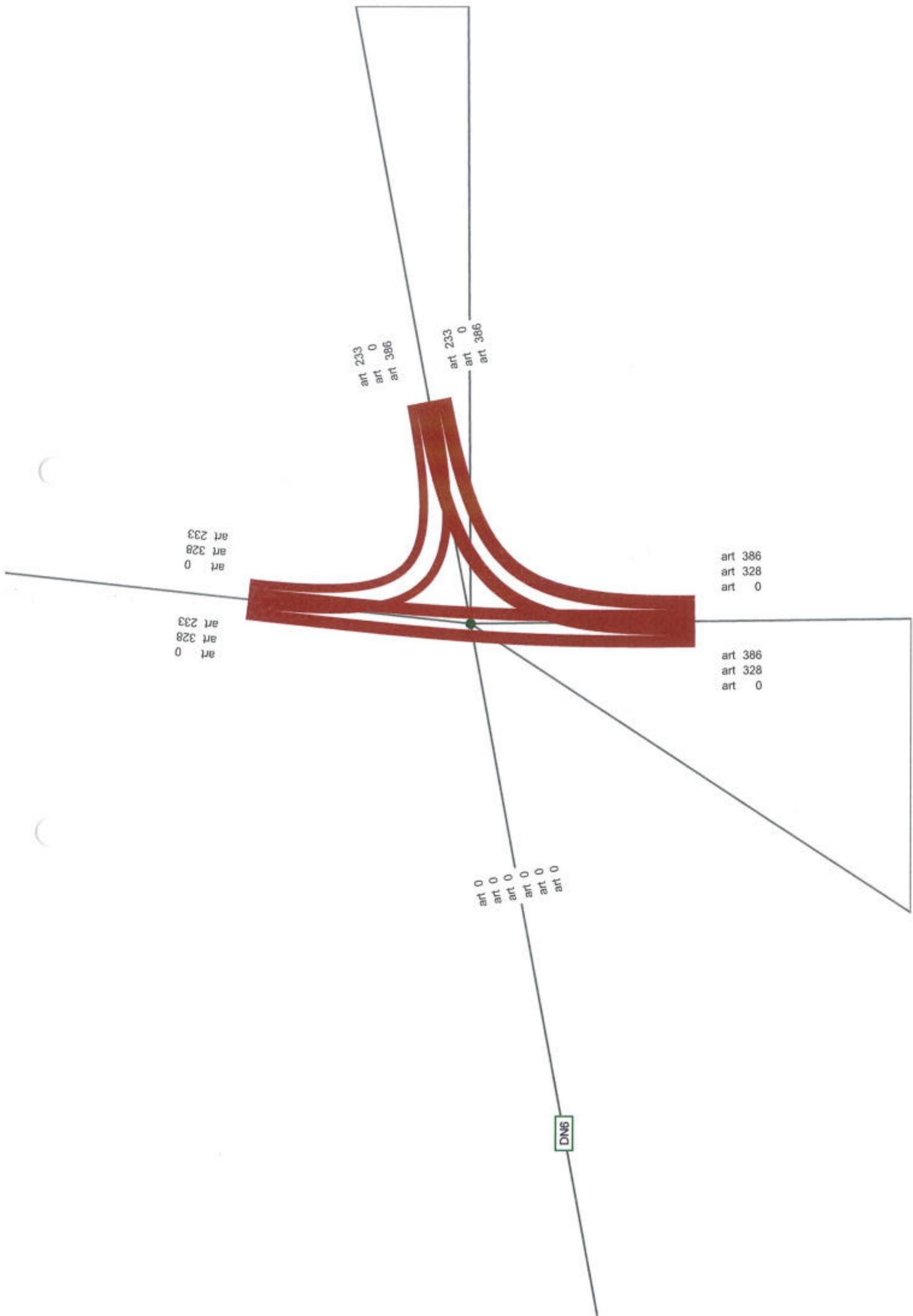


2030









art 233
art 328
art 0

art 386
art 328
art 0

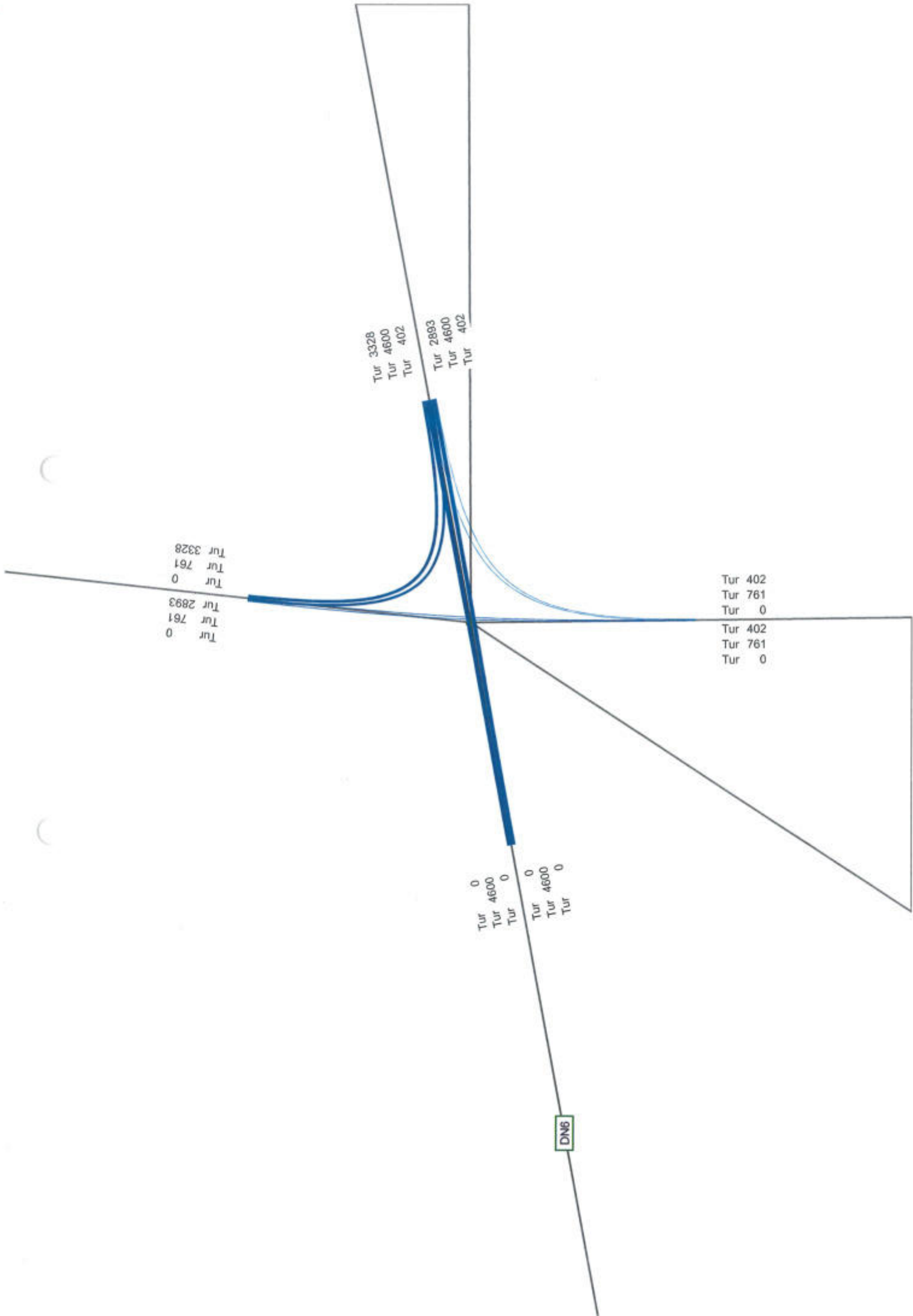
art 233
art 0
art 386

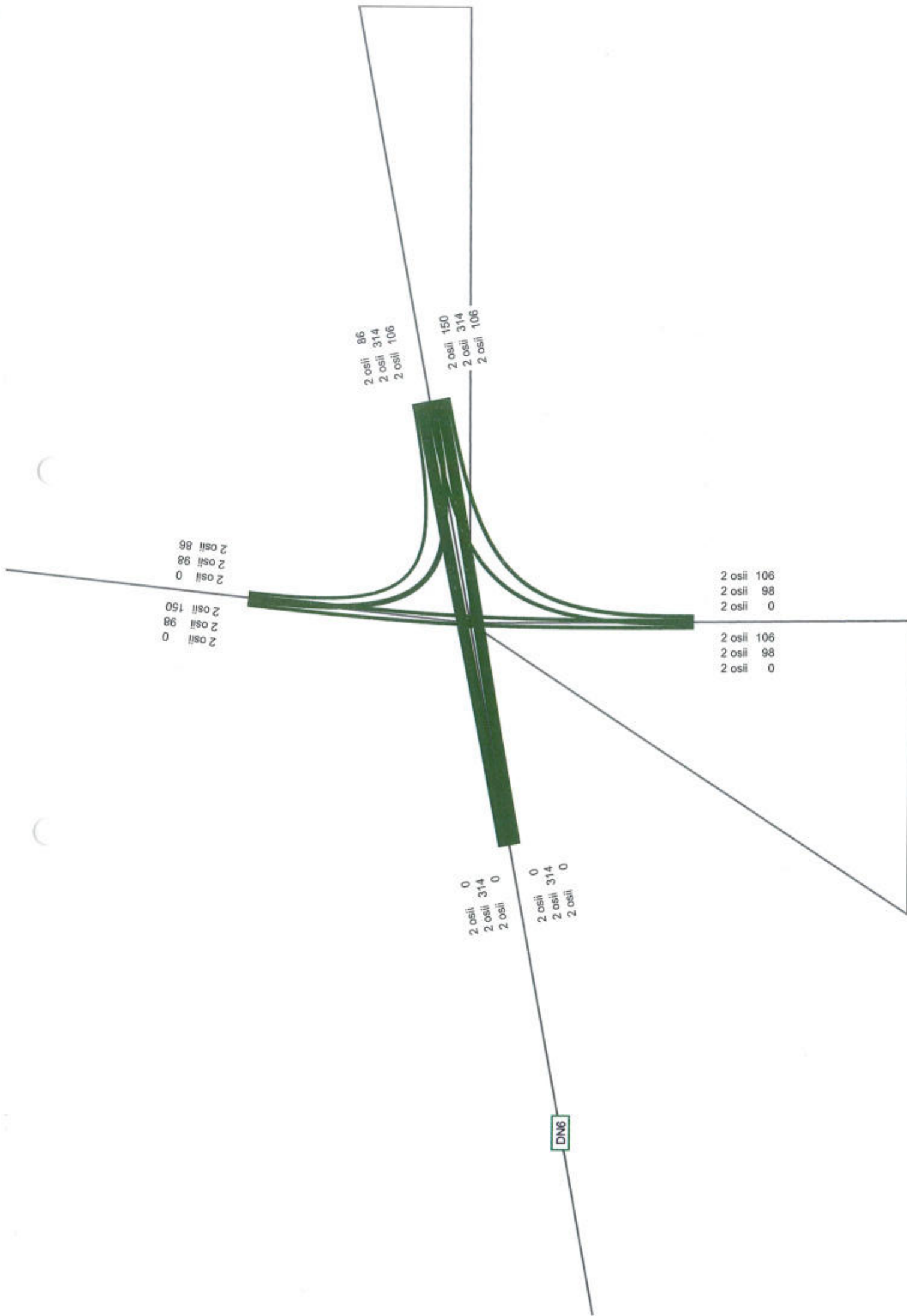
art 233
art 0
art 386

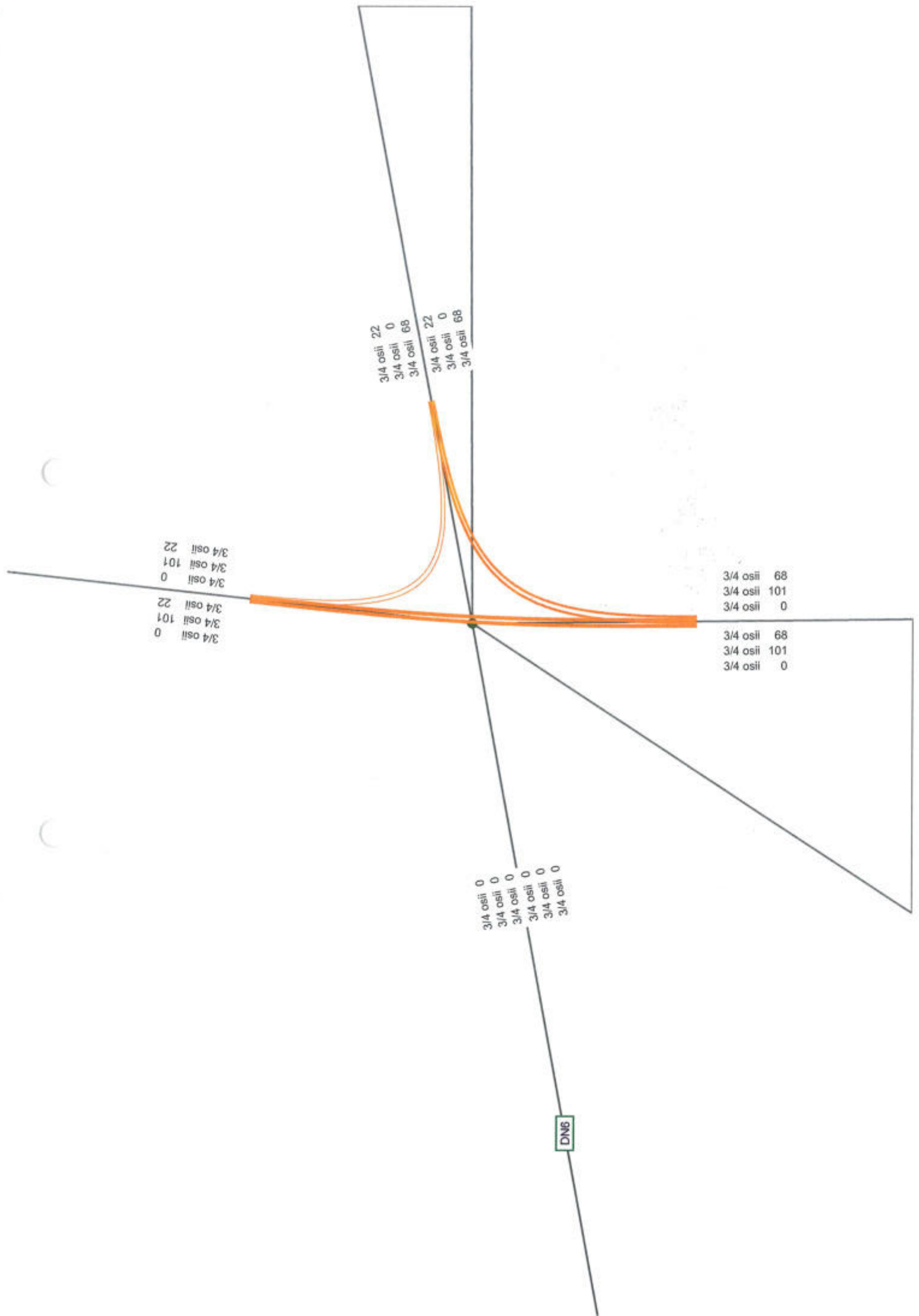
art 0
art 0
art 0
art 0
art 0
art 0

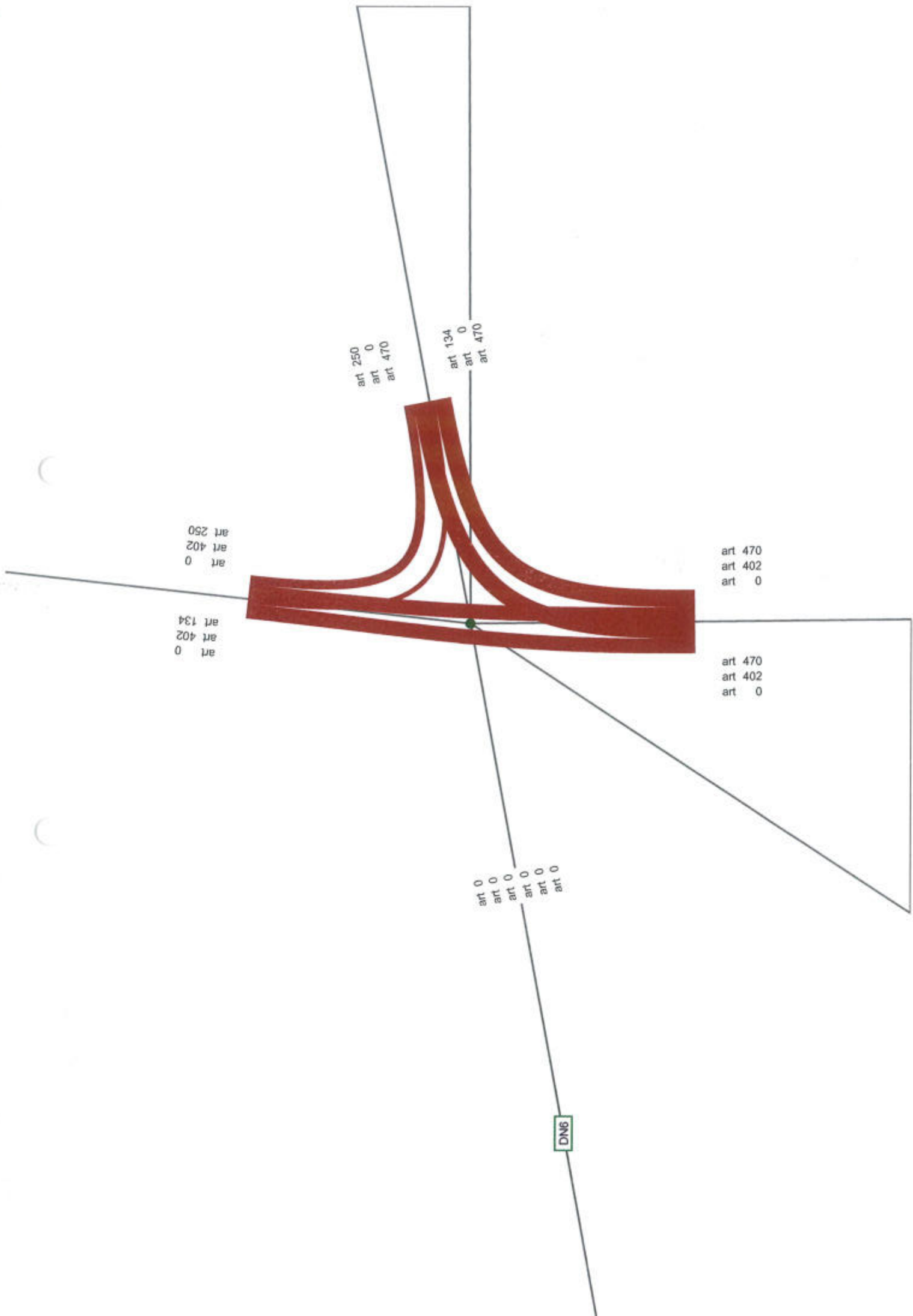
DN6

2035

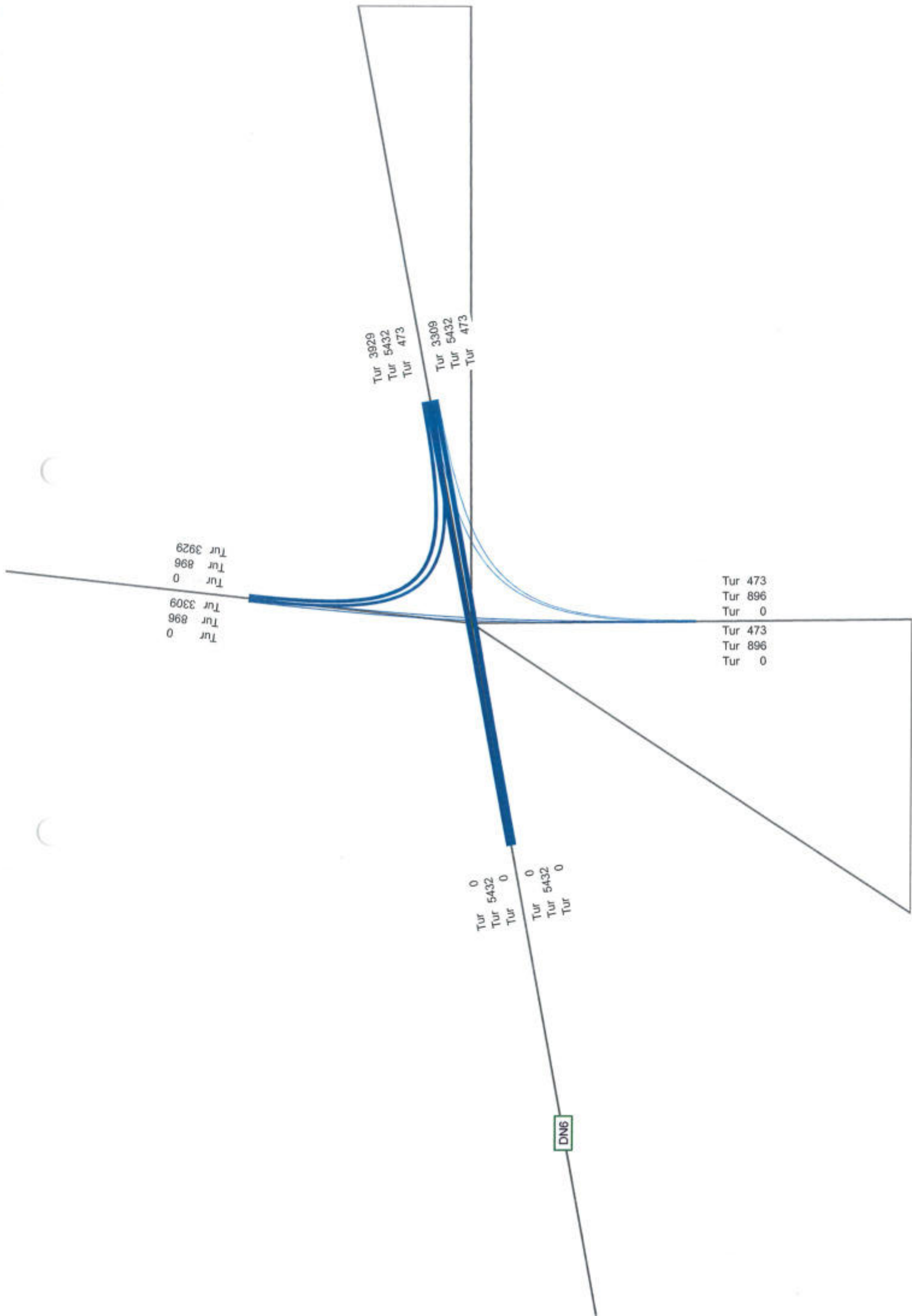


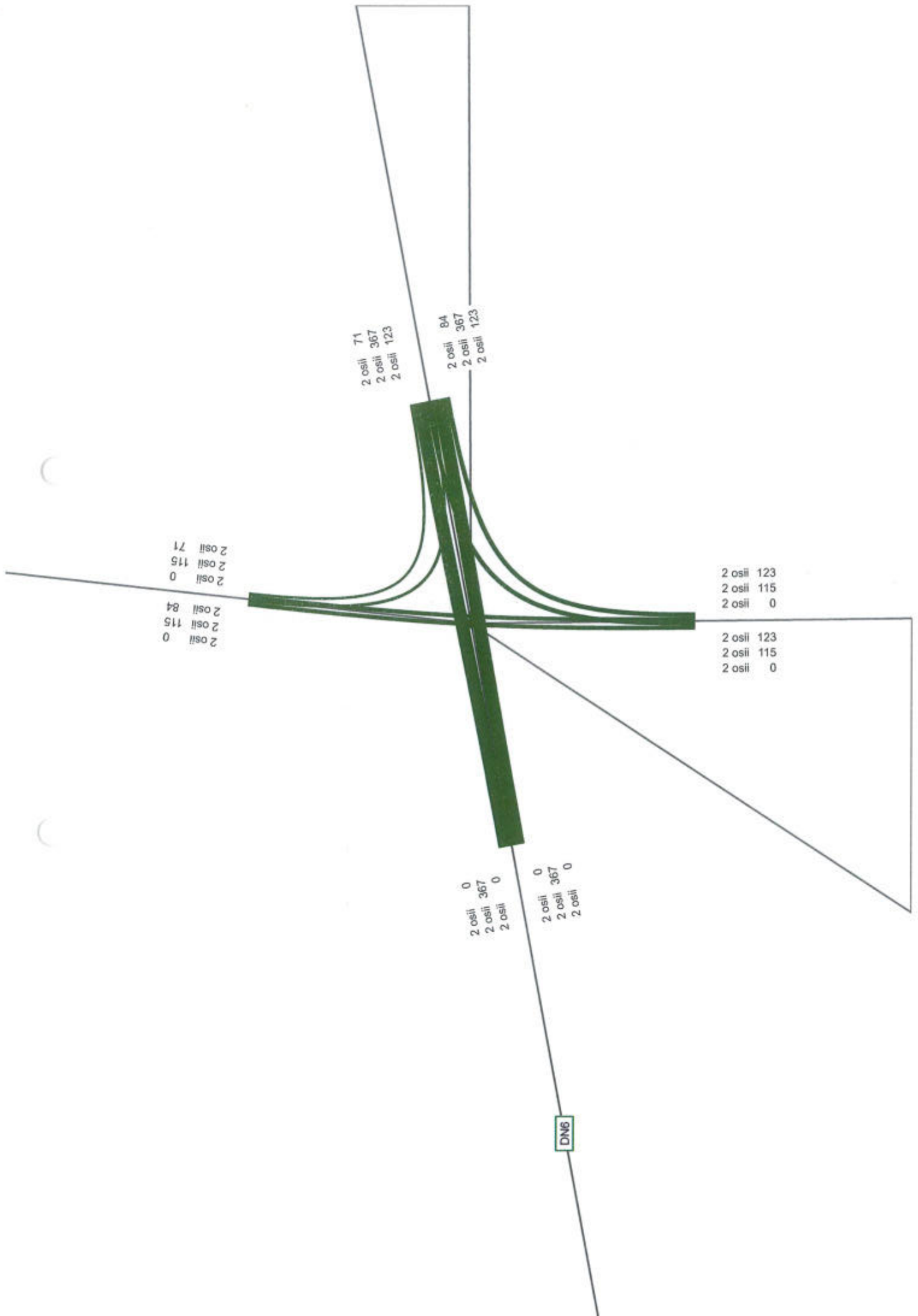


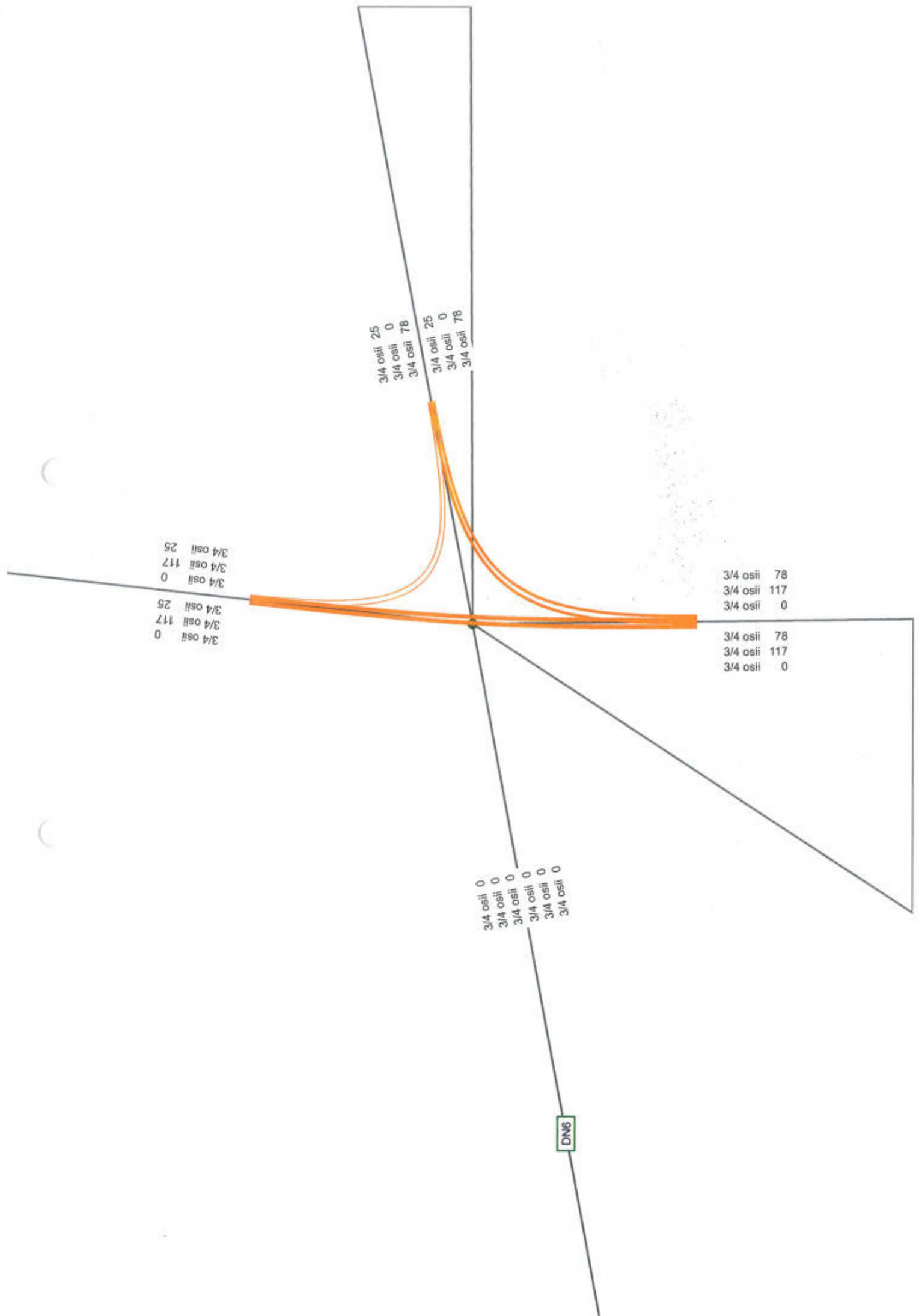


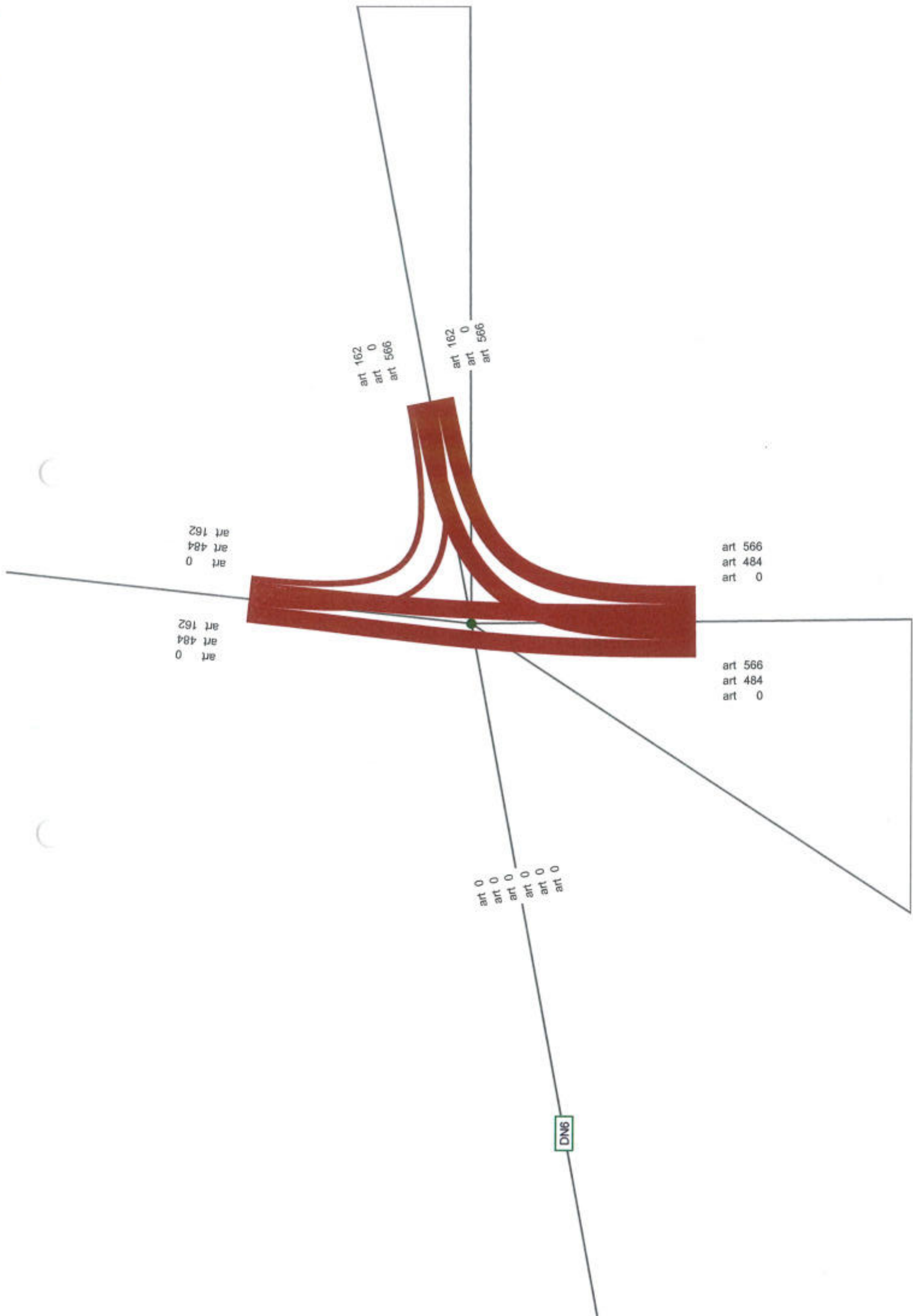


2040









TRAFCUL MEDIU ZILNIC ANUAL - DRUMURI JUDETENE - TIMIS- 2015

Cod unit.	Nr. post	Nr. drum DJ	Pozitie km post	Limita sector (km)		Lung sector	Bucata, motosiclete	Autoturisme 8+1 locuri	Motosiclete si autoturisme cu MTVA ca 3,5 tone	Autoturisme si denarii cu etusa axa	Autoturisme si denarii cu trei axe peru axa	Autoturisme remontrare cu trac, vehicule cu peste 4 axe	Autobuze si autocare	Tractoare culturale remorca, vehicule speciale	Autoturisme cu 2,3 sau 4 axe, cu remorci (tron auto)	Vehicule cu tractare antrata	Total vehicule	Limita sector		
				de la	la															
41	1891		572	65.900	55.700	66.670	10.920	46	551	17	29	11	10	11	6	5	3	692	LIM JUD CS - BUZIAS	
41	1892		572	74.000	66.670	84.582	17.962	47	337	10	45	12	28	31	5	7	2	530	BUZIAS - DN 6	
41	1894		584	1.500	1.100	23.359	23.259	22	469	19	84	107	35	13	11	4	1	669	M LUCOI - LIM JUD CS	
41	1898		591	11.800	6.255	27.027	20.775	73	1.849	145	151	107	47	121	102	14	6	2.627	M TIMISOARA - DN 59B	
41	1899		592	8.100	5.100	16.800	11.700	152	8.495	152	994	131	154	106	114	9	5	4.652	M TIMISOARA - DI 592A	
41	1900		592	26.500	16.800	31.000	14.200	41	3.267	80	474	261	164	285	60	9	6	3.134	DI 572 - M LUCOI	
41	1901		592	44.099	31.000	54.478	21.478	20	2.019	145	238	156	160	234	97	20	3	3.134	DI 572 - M LUCOI	
41	1906		593	11.100	0.000	19.400	19.400	16	1.646	40	100	45	12	41	52	8	4	1.966	DN 59 - DI 609B	
41	1907		593	24.200	19.400	31.540	13.140	6	384	20	37	9	4	12	11	5	1	490	DI 609B - DN 59B	
41	1908		594	9.000	0.000	17.218	17.218	20	408	50	26	8	5	11	15	7	3	535	DN 59A - DI 594A (GOITLOB)	
41	1909		594	17.400	17.218	23.023	5.815	33	644	45	92	21	15	29	15	14	5	926	DI 594A - DN6 (LOVRIN)	
41	1861		595	3.600	0.000	11.321	11.321	23	3.627	245	736	92	69	57	61	12	2	4.639	DN59 - GROC-M TIMISOARA	
41	1913		629	19.500	17.250	38.230	23.880	33	1.605	6	92	9	6	120	13	8	2	331	DI 609B - LIM JUD AR	
41	1918		680	2.700	2.700	15.356	12.656	68	671	15	76	11	52	120	13	4	2	1.033	M LUCOI - CACIOVA	
41	1920		681	1.500	0.000	16.400	16.400	59	682	57	81	50	118	120	22	7	8	1.206	DN 58A - DI 681A	
41	1921		681	19.050	16.400	28.700	11.800	4	80	6	16	4	20	13	1	5	0	191	DI 681A - DI 681B (NADRAG)	
41	1922		681	40.800	28.700	43.562	15.352	20	292	15	41	11	55	47	10	3	0	599	NADRAG - DN 6 (GAYVOIDIA)	
41	1923		682	2.100	0.000	9.502	9.502	8	240	6	41	13	18	117	1	1	0	447	DN68A-LIM JUD AR	
41	1924		682	147.350	132.158	154.537	23.379	36	832	65	94	27	14	62	59	12	8	1.215	DI 692 (PERIAN) - DN 6	
41	1926		682	174.550	167.938	193.103	25.165	19	246	10	9	7	6	6	29	7	2	341	DI 682B - FRONT SERBIA	
41	1925		684	4.300	0.000	19.105	19.105	32	475	36	35	24	4	4	14	5	8	661	DN 68A (COSVAI) - DC114 (TOMESTI)	
41	1930		691	4.500	2.600	10.200	7.600	266	8.795	285	588	267	143	163	292	5	7	0	10.912	M TIMISOARA-DC38 (GEARNAVIA)
41	1931		691	18.400	10.200	33.778	23.578	42	1.547	125	65	71	5	153	52	6	5	2.135	CIARNAVIA - DI 693 (FIBIS)	
41	1932		691	34.000	33.978	42.197	8.219	17	646	26	63	33	36	86	47	10	2	969	DI 693 - LIM JUD AR	
41	1934		692	4.000	0.000	18.548	18.548	126	2.413	74	73	29	33	31	38	30	4	3.046	DN 69 - DI 693	
41	1936		692	39.500	18.548	40.700	21.652	8	775	61	73	29	33	31	38	30	6	1.083	DI 693 - PERIAN (DI 582)	
41	1939		693	6.400	0.000	12.212	12.212	61	662	56	60	24	11	35	29	14	6	965	DN 59A - DN 6	
41	1937		693	31.400	27.005	35.400	5.400	10	220	15	31	17	6	44	3	4	3	358	DI 692 - DN 69	
41	1935		588A	17.000	0.000	18.256	18.256	95	645	35	37	14	7	6	30	7	18	897	DN58B - DN59	
41	1867		591A	16.000	0.000	16.757	16.757	14	193	15	17	2	2	6	21	6	3	287	DI 591 - DI 593	
41	1902		592A	3.500	0.000	7.528	7.528	24	924	49	72	45	2	85	46	10	2	1.066	DI 592 - DI 693B (OLVESTI)	
41	1866		594A	0.700	0.000	8.730	8.730	15	240	11	46	3	5	20	4	14	5	364	DI 594 - DN 59C (COALDUSI MARE)	
41	1914		609A	3.000	0.000	18.459	18.459	39	691	21	120	87	18	13	30	7	1	750	DN 6 - LIM JUD AR	
41	1916		609B	1.000	0.000	18.459	18.459	39	691	21	120	87	18	13	30	7	8	1.016	DN 6 - DI 609	
41	1917		609B	28.000	18.459	34.123	15.664	33	233	12	67	4	8	2	7	5	1	372	DI 609 - DN 68A	
41	1862		609D	4.543	0.000	8.979	3.986	48	2.918	402	376	330	389	842	301	2	103	5.707	DN6A-EROPORT	
41	1955		681A	7.050	0.000	12.500	12.500	38	283	7	13	15	8	8	6	7	3	390	DI 681 - DN 68A	
41	1947		693B	19.700	12.303	26.000	13.697	94	295	33	13	8	4	1	18	10	7	484	DI 595 - CACIOVA (DI 595A)	
41	1948		693B	33.000	26.000	33.756	7.756	36	765	27	102	6	9	8	38	6	1	999	CACIOVA - DN 59 (IEBEL)	
41	1949		693B	44.200	33.756	32.651	18.895	44	624	27	50	59	35	66	28	18	2	999	DN 59 - DI 592A (OTVESTI)	

BREVIAR DE CALCUL LUCRARI CONSOLIDARE

VARIANTA DE OCOLIRE TIMISOARA SUD

LUCRARI CONSOLIDARE

- | | |
|-----------------------|-----------------------------------|
| 1. Denumirea lucrării | Varianta de Ocolire Timisoara Sud |
| 2. Obiectiv | Lucrari de Consolidare |
| 3. Beneficiar | |
| 4. Adresa | |
| 5. Executant proiect | |

Elaborare Proiect,

Ing. Teodor Malancu MSc.

Aprobat,

Ing.

Verificat la exigența Af,

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1. PREZENTAREA GENERALA

Proiectarea Geotehnica

Proiectarea geotehnica, ca si ramura a ingineriei civile, are la baza metode semi-probabilistice a starilor limita.

In conformitate cu standardul SR EN 1990, se utilizeaza doua tipuri de stari limita;

- stari limita ultime (SLU)
- stari limita de exploatare (serviciu) (SLE)

Starile limita ultime sunt cele care au in vedere siguranta oamenilor si a constructiilor si sunt asociate cu prabusirea sau alte forme similare de cedare a structurale.

Starile limita de exploatare (serviciu) sunt cele care au in vedere exploatarea normala si confortul oamenilor, corespunzand stadiilor dincolo de care inceteaza a mai fi indeplinite cerintele impuse de exploatarea constructiei in ansamblu sau a unei parti din constructie.

Situatii de proiectare

Standardul SR EN 1997-1 impune luarea in considerare in proiectarea geotehnica a asa numitelor situatii de proiectare, care trebuie astfel alese incat sa acopere toate conditiile fizice care pot aparea pe parcursul executiei si exploatarei constructiilor. In SR EN 1990, situatia de proiectare este definita drept un set de conditii fizice reprezentand conditiile reale intalnite intr-un interval de timp, pentru care proiectarea demonstreaza ca starile limita relevante nu sunt depasite.

La proiectare, trebuie avute in vedere situatiile de proiectare pe termen scurt si pe termen lung.

Un criteriu principal pentru luarea in considerare a factorului timp in definirea situatiei de proiectare il reprezinta permeabilitatea pamantului. Astfel, in cazul in care permeabilitatea pamantului saturat este redusa, iar timpul necesar pentru disiparea apei din pori este mare in comparatie cu durata executiei, pentru verificarea la starea limita ultima situatiile de proiectare trebuie sa se refere atat la conditiile nedrenate, cat si la cele drenate. La situatiile de proiectare pe termen scurt, conditiile nedrenate vor fi hotaratoare in cazul pamanturilor argiloase, de consistenta redusa sau medie, deoarece disiparea in timp a presiunii apei din pori este insotita de o crestere a rezistentei la forfecare a pamantului.

Proiectarea geotehnica prin calcul

Factorii care intervin in proiectarea geotehnica prin calcul sunt:

- actiunile, care pot fi incarcari impuse sau deplasari impuse;
- proprietatile pamanturilor care alcatuiesc terenul de fundare, precum si proprietatile materialelor de constructii
- valorile limita ale deformatiilor, deschiderea fisurilor, vibratiile, etc.
- modelele de calcul asociate cu starile limita ultime si de exploatare, in masura sa anticipeze efectul actiunilor asupra rezistentei si deformatiei terenului.

Proiectarea geotehnica prin calcul reprezinta metoda de proiectare curent utilizata. Totusi, SR EN 1997-1 atrage atentia asupra faptului ca recunoasterea conditiilor de teren depinde de volumul si de calitatea investigarii terenului de fundare. Aceasta recunoastere, precum si controlul calitatii executiei lucrarilor, sunt uneori mai importante pentru satisfacerea cerintelor fundamentale decat precizia in modelele de calcul si in coeficientii partiali.

Pentru un calcul eficient trebuie facuta distinctia intre stari limita ultime si stari limita de exploatare. Verificarea uneia dintre cele doua categorii de stari limita poate fi omisa daca sunt disponibile suficiente

informatii pentru a demonstra ca se indeplineste cealalta. Starile limita trebuie asociate cu situatiile de proiectare.

Situatiile relevante de proiectare trebuie selectate tinand seama de circumstantele in care se cere ca structura sa isi indeplineasca functiunea.

Situatiile de proiectare trebuie sa se clasifice astfel:

- situatii de proiectare permanente, care se refera la conditii normale de utilizare
- situatii de proiectare tranzitorii, ce se refera la conditii tranzitorii aplicabile structurii, de exemplu in timpul executiei sau reparatiei
- situatii de proiectare accidentale, care se refera la conditii exceptionale aplicabile structurii sau la expunerea acesteia, de exemplu, impact sau consecinte ale cedarii locale
- situatii de proiectare seismice, care se refera la conditii aplicate structurii cand este supusa la evenimente seismice

Situatiile de proiectare alese trebuie sa fie suficient de severe si variate in asa fel incat sa includa toate conditiile care pot aparea in mod previzibil in timpul executiei sau utilizarii structurii.

Verificarea echilibrului static

Tinand seama de specificul lucrarii (rambleu de pamant), conform SREN 1997-1, starile limita ultime care trebuie verificate sunt:

- GEO: cedarea sau deformatia excesiva a terenului in care rezistenta pamanturilor contribuie in mod semnificativ la asigurarea rezistentei,
- STR: cedarea interna sau deformatia excesiva a structurii sau elementelor de structura, in care rezistenta materialelor structurii contribuie semnificativ la asigurarea rezistentei.

In cuprinsul breviarului de calcul sunt prezentate valorile factorului de stabilitate F_s in cazul stabilitatii generale a terasamentelor.

In calcul s-au luat in considerare datele geotehnice din forajelele executate in amplasamentul lucrarilor si profilele transversale cele mai apropiate de lucrare.

Pentru calcul s-au parcurs urmatoarele:

- 1) identificarea unei sectiuni critice de calcul, corespunzatoare unei zone de drum cu inaltime de rambleu mare si teren de fundare dificil;
- 2) stabilirea valorilor de calcul pentru parametrii geotehnici, pornind de la datele geotehnice disponibile. Valorile de calcul au rezultat din valorile determinarilor din incercarile de laborator si teren corectate si in urma unui calcul statistic a valorilor grupate pe tipuri de pamanturi acolo unde aceste date de laborator nu sunt suficiente;
- 3) stabilirea coloanei litologice si a stratificatiei in zona lucrarilor, cu obtinerea unei sectiuni de calcul caracterizata prin litologie, geometrie si parametri de calcul;
- 4) calculul propriu-zis al factorului de stabilitate al terasamentului in sectiunea critica.
- 5) analiza stabilitatii folosind modelul problemei plane de deformatii in ipoteza unei legi de material elastic perfect plastic, cu utilizarea criteriului de cedare Mohr – Coulomb
- 6) calculul deformabilitatii terasamentelor cu considerarea fenomenelor reologice (consolidare).

Selectarea profilelor de calcul si a caracteristicilor terenului

Profilele au fost selectate in functie de geometrie (au fost alese rambleurile cu inaltimea maxima), caracteristicile terenului si nivelul apei subterane.

Datele de baza (descrierea straturilor, fisele de foraj, rezultatele analizelor in-situ si de laborator, monitorizarea nivelului piezometric) au fost preluate din Studiul Geotehnic.

Alegerea parametrilor

Caracteristicile umpluturii utilizate în analiza rambleurilor au fost luate ca medie a caracteristicilor pamanturilor locale rezultate din excavatii, dar ținând cont și de îmbunătățirea acestora datorită compactării:

$$\gamma = 18 \text{ kN/m}^3$$

$$E = 20.000 \text{ kPa}$$

$$\nu = 0.35$$

$$\phi_k = 15^\circ$$

$$c_k = 25 \text{ kPa}$$

$$k = 1 \times 10^{-7} \text{ cm/s}$$

Materialul granular utilizat la armarea pamantului cu geogridurile are următorii parametri:

$$\gamma = 20 \text{ kN/m}^3$$

$$E = 30000 \text{ kPa}$$

$$\nu = 0.27$$

$$\phi_k = 35^\circ$$

$$c_k = 2 \text{ kPa}$$

$$k = 0.01 \text{ cm/s}$$

Stabilirea valorilor caracteristice ale parametrilor geotehnici prin estimare prudentă

Valoarea caracteristică a unui parametru geotehnic este stabilită ca estimare prudentă a valorii care influențează apariția stării limită. Aceasta prevede din SR EN 1997-1 are în vedere următoarele:

- este implicată gândirea inginerescă;
- este necesar un anumit grad de conservatorism în evaluare;
- este necesar să fie corelată valoarea caracteristică stabilită cu starea limită, cu alte cuvinte pot exista pentru același parametru mai multe valori caracteristice, fiecare asociată cu o anumită stare limită.

Metoda de analiză a stabilității

Metodele și metodologia folosite pentru analiză stabilității la alunecare a taluzurilor sunt conform SR EN 1997-1, SR EN 1997-1/NB și GP129-2014.

Analiza stabilității s-a făcut folosind metodele echilibrului-limită, modelul Bishop și metoda Janbu. Metoda Bishop are la bază următoarele ipoteze:

Ruperea se produce după o suprafață unică de cedare, cilindrică cu ax orizontal;

Cedarea se produce dintr-o singură mișcare (nu se ține seama de deformările ce se produc înainte de rupere); Rezistența la forfecare în lungul suprafeței de rupere, corespunde aceleiași deformări și în consecință aceluiasi grad de mobilizare a rezistenței la forfecare;

Masa alunecătoare de pamant care tinde să lunece este discretizată în fasii verticale, ținându-se seama de reacțiunile dintre fasii;

Coeficientul de siguranță este definit ca raportul dintre rezistența la forfecare disponibilă și cea mobilizată egală cu componenta tangentială a tensiunii totale aplicată pe suprafața de cedare.

Metoda Janbu are la bază următoarele ipoteze

Suprafața de cedare este de formă oarecare;

Ruperea se produce brusc (nu se ține seama de deformările ce se produc înainte de cedare);

Coeficientul de siguranță este definit ca raportul dintre rezistența la forfecare disponibilă și rezistența la forfecare necesară asigurării echilibrului este considerat constant în lungul suprafeței potențiale de cedare

Calculul de stabilitate generala a fost efectuat cu un program de calcul bazat pe metoda echilibrului limita care are implementate cerintele SR EN 1997-1:2004 determinand un coeficient de utilizare.

Conform SR EN 1997-1 / 2004, pentru starea limita de cedare a terenului (GEO) trebuie sa se verifice conditia $R_d \geq E_d$, in care R_d este valoarea de calcul a rezistentelor (rezistenta la forfecare disponibila) si E_d este valoarea de calcul a efectului actiunilor (rezistenta la forfecare mobilizata).

Din acest raport rezulta factorul de stabilitate minim (F_s) cu conditia ca:

$$R_d \geq E_d, \text{ deci } F_s \text{ min.} = R_d / E_d \geq 1$$

Seism

Analizele de stabilitate sunt realizate în condiții dinamice (seism cu $a_g = 0.20g$ conform P100/2013).

Nivelul apei subterane

Nivelul apei subterane se va lua in calcul pe baza masuratorilor efectuate.

Incarcarea din trafic

Pentru a rambleuri, supraincarcarea din trafic s-a considerat conform STAS 1545-89 si STAS 3221-86 (aflate in vigoare la data 01-01-2014) ca fiind echivalenta cu presiunea data de un strat de pamant cu inaltimea de 1.30m: $q = 1.30m \times 20kN/m^3 = 26 \text{ kPa}$.

Calcul tasare rambleu

Date generale

Constructia corpului drumului, a rambleelor inalte si a rampelor podurilor si pasajelor pe aceste terenuri necesita luarea unor masuri speciale de imbunatatire a capacitatii portante a acestora atunci cand terenul natural slab nu poate fi inlocuit din considerente economice sau tehnologice.

Au fost efectuate verificari ale deformatiilor rambleurilor inalte cu inaltime mai mare de 6.00 m.

Prin deformatia terenului din baza rambleurilor inalte se intelege deplasarea pe verticala produsa ca urmare a incarcarilor provenite din umplutura rambleului la baza acestuia.

Pentru efectuarea calculului deformatiilor este necesar sa se cunoasca stratificatia terenului reprezentata prin foraje care sa precizeze succesiunea si grosimea straturilor, caracteristicile fizice si mecanice ale pamanturilor.

Daca in urma efectuarii calculelor de deformabilitate a terenului de fundare rezultatele acestora arata ca terenul de fundare nu are capacitatea de preluare a incarcarilor date de rambleu sau sufera tasari majore care pot pune in pericol siguranta constructiei trebuie sa se examineze oportunitatea imbunatatirii proprietatilor pamantului din stratul respectiv, astfel incat sa indeplineasca conditiile unui teren bun de fundare.

Solutiile de imbunatatire a terenului de fundare s-au stabilit in functie de natura terenului de fundare, de grosimea stratului de pamant supus imbunatatirii, de sensibilitatea la umezire a acestuia.

Calcul la starea limita de serviciu (SLS)

Potrivit SR-EN 1997-1:2004, pentru SLS este necesara estimarea tasarii terenului de fundare de sub rambleu. Notele de calcul au scopul determinarii valorii maxime a tasarii rambleului nou la nivelul terenului de fundare si la partea superioara, in ax.

Calculul tasarii rambleului presupune parcurgerea următoarelor etape:

- stabilirea valorilor de calcul pentru parametrii geotehnici pornind de la datele existente; valorile de calcul au rezultat în urma unui calcul statistic a valorilor grupate pe straturi omogene acolo unde volumul de informații a permis această analiză,
- simplificarea litologiei acolo unde variațiile parametrilor fizico – mecanici au fost reduse și obținerea în final a unei stratificații de calcul identificată prin natură, geometrie și parametri de calcul,
- calculul deformabilității terasamentelor cu considerarea fenomenelor reologice (consolidare).

Profilul a fost selectat în funcție de geometrie, fiind ales rambleul cu înălțimea maximă, din zona structurii, coroborat cu caracteristicile terenului și nivelul apei subterane.

Datele de baza (descrierea straturilor, fisele de foraj, rezultatele analizelor in-situ și de laborator, monitorizarea nivelului piezometric) au fost preluate din Studiul Geotehnic.

Stratificatia terenului, adancimile stratelor, precum și valorile de calcul ale parametrilor rezistentei la forfecare, precum și caracteristicile acestora sunt preluate din fisa forajului.

2. CALCULE STABILITATE SI TASARE

2.1 Rambleu km 0+600

2.1.1 Calcul stabilitate si tasare

Slope stability analysis KM 0+600

Settings

Standard - EN 1997 - DA3

Stability analysis

Earthquake analysis : Standard

Verification methodology : according to EN 1997

Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	

Partial factors for soil parameters (M)		
Permanent design situation		
Partial factor on internal friction :	$\gamma_\phi =$	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40 [-]

Partial factors on actions (A)					
Seismic design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.00 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.00 [-]	0.00 [-]	1.00 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	

Partial factors for soil parameters (M)		
Seismic design situation		
Partial factor on internal friction :	$\gamma_\phi =$	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40 [-]

Soil parameters

Material umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 18.00^\circ$
 Cohesion of soil : $c_{ef} = 22.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Argila maronie

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective

Angle of internal friction : $\varphi_{ef} = 10.00^\circ$
 Cohesion of soil : $c_{ef} = 30.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Nisip fin

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 26.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude	
1	strip	permanent	on terrain	x = 25.00	l = 10.00		0.00	q, q ₁ , f, F	q ₂ unit
								26.00	kN/m ²

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters					
Center :	x =	16.76 [m]	Angles :	$\alpha_1 =$	-25.44 [°]
	z =	37.45 [m]		$\alpha_2 =$	67.91 [°]
Radius :	R =	15.86 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : $F_a = 770.29 \text{ kN/m}$
 Sum of passive forces : $F_p = 962.64 \text{ kN/m}$
 Sliding moment : $M_a = 12216.79 \text{ kNm/m}$
 Resisting moment : $M_p = 15267.43 \text{ kNm/m}$
 Utilization : 80.0 %

Slope stability ACCEPTABLE

Input data (Stage of construction 2)

Earthquake

Horizontal seismic coefficient : $K_h = 0.10$
 Vertical seismic coefficient : $K_v = 0.05$

Settings of the stage of construction

Design situation : seismic

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters					
Center :	x =	17.17 [m]	Angles :	$\alpha_1 =$	-30.75 [°]
	z =	39.33 [m]		$\alpha_2 =$	65.17 [°]

Slip surface parameters

Radius : R = 18.88 [m]

The slip surface after optimization.

Slope stability verification (Bishop)

Sum of active forces : $F_a = 1078.32 \text{ kN/m}$

Sum of passive forces : $F_p = 1171.91 \text{ kN/m}$

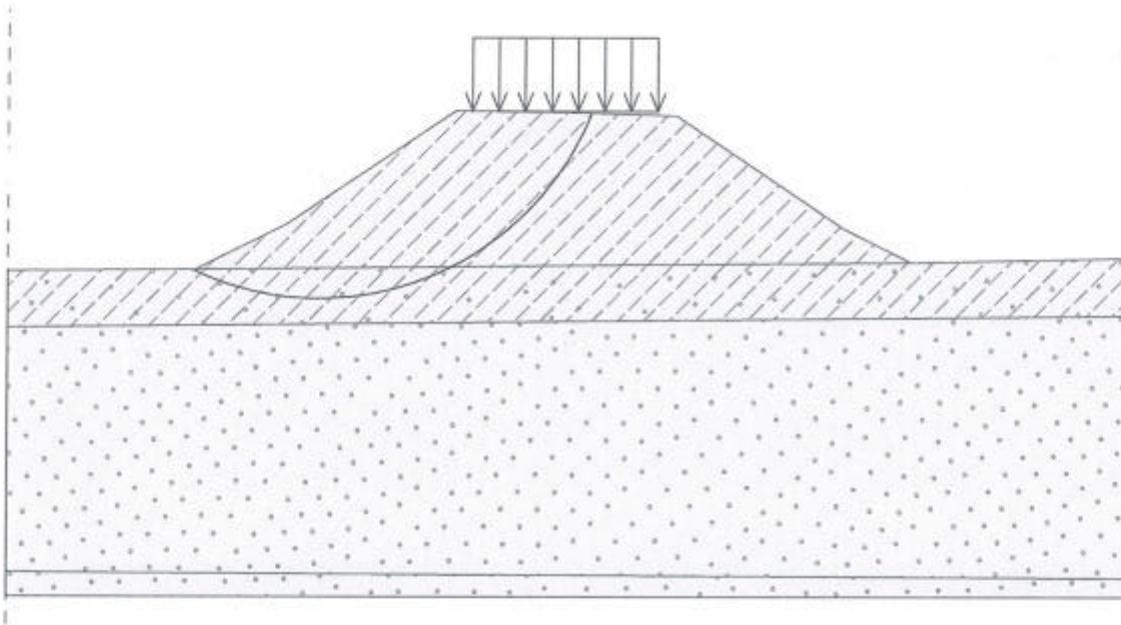
Sliding moment : $M_a = 20358.77 \text{ kNm/m}$

Resisting moment : $M_p = 22125.67 \text{ kNm/m}$

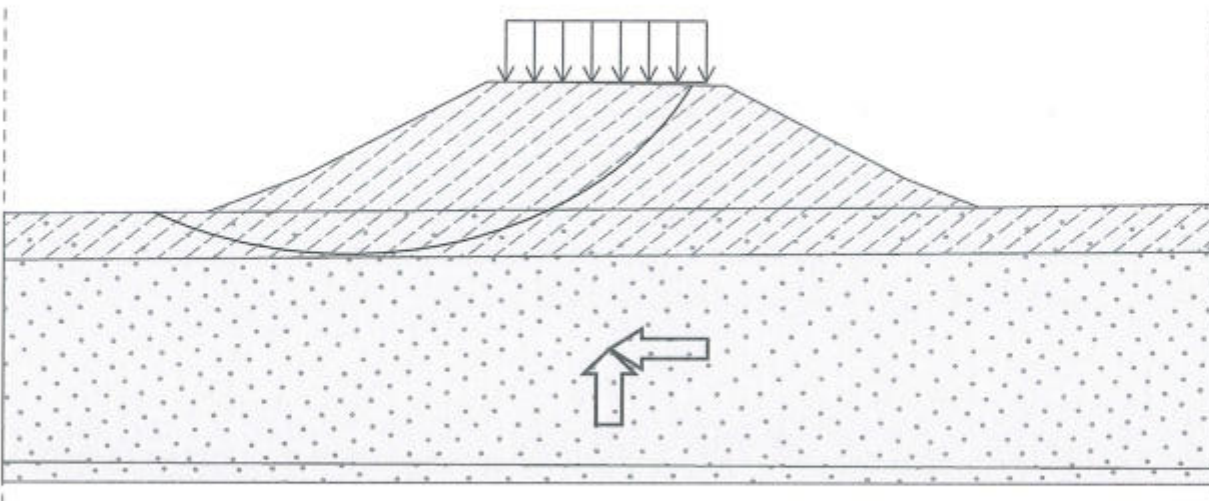
Utilization : 92.0 %

Slope stability ACCEPTABLE

Static



Dynamic



Settlement analysis KM 0+600

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Soil parameters

Mat umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

A marinie

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 18.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Nisip fin

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 25.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Surcharge

No.	Surcharge		Type	Location	Origin	Length	Width	Distance from axes	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 25.00	l = 10.00			26.00		kN/m ²

Surcharges

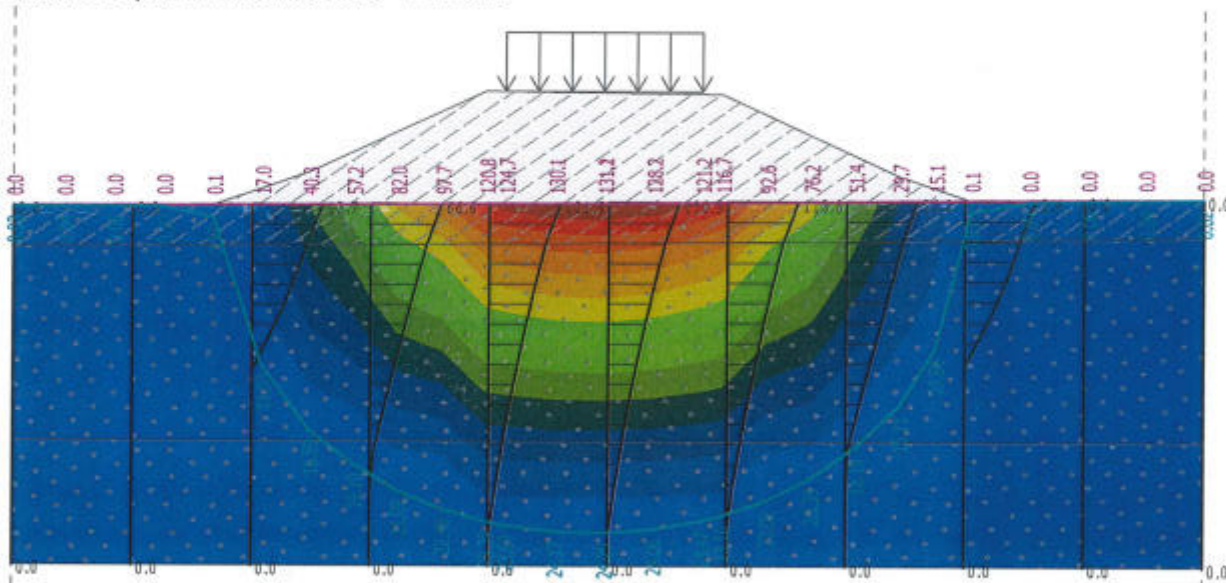
No.	Name
1	q

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 131.2 mm

Maximum depth of influence zone = 24.29 m



2.2 Rambleu km 1+520

2.2.1 Calcul stabilitate

Slope stability analysis km 1+520

Settings

Standard - EN 1997 - DA3

Stability analysis

Earthquake analysis : Standard

Verification methodology : according to EN 1997

Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	

Partial factors for soil parameters (M)		
Permanent design situation		
Partial factor on internal friction :	$\gamma_\phi =$	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40 [-]

Soil parameters

Argila

Unit weight : $\gamma = 17.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 12.00^\circ$
 Cohesion of soil : $c_{ef} = 35.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Argilos

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 15.00^\circ$
 Cohesion of soil : $c_{ef} = 28.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Mat. umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 18.00^\circ$
 Cohesion of soil : $c_{ef} = 22.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Nisip


Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 29.00^\circ$

Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Perna balast+grila

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 15.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Rigid bodies

No.	Name	Sample	γ [kN/m ³]
1	Zid PA		22.00

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude	
1	strip	permanent	on terrain	x = 25.00	l = 10.00		0.00	q, q ₁ , f, F	unit
								26.00	kN/m ²

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters					
Center :	x =	13.94 [m]	Angles :	$\alpha_1 =$	-25.28 [°]
	z =	20.99 [m]		$\alpha_2 =$	66.23 [°]
Radius :	R =	19.33 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : $F_a = 963.18 \text{ kN/m}$

Sum of passive forces : $F_p = 1330.36 \text{ kN/m}$

Sliding moment : $M_a = 18618.33 \text{ kNm/m}$

Resisting moment : $M_p = 25715.91 \text{ kNm/m}$

Utilization : 72.4 %

Slope stability ACCEPTABLE

Input data (Stage of construction 2)

Earthquake

Horizontal seismic coefficient : $K_h = 0.10$

Vertical seismic coefficient : $K_v = 0.05$

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters					
Center :	x =	13.08 [m]	Angles :	$\alpha_1 =$	-2.15 [°]
	z =	24.97 [m]		$\alpha_2 =$	55.07 [°]
Radius :	R =	20.61 [m]			
The slip surface after optimization.					

Reinforcement forces

Reinforcement	Force [kN/m]
1	40.00
2	0.00
3	0.00
4	0.00

Slope stability verification (Bishop)

Sum of active forces : $F_a = 654.35$ kN/m

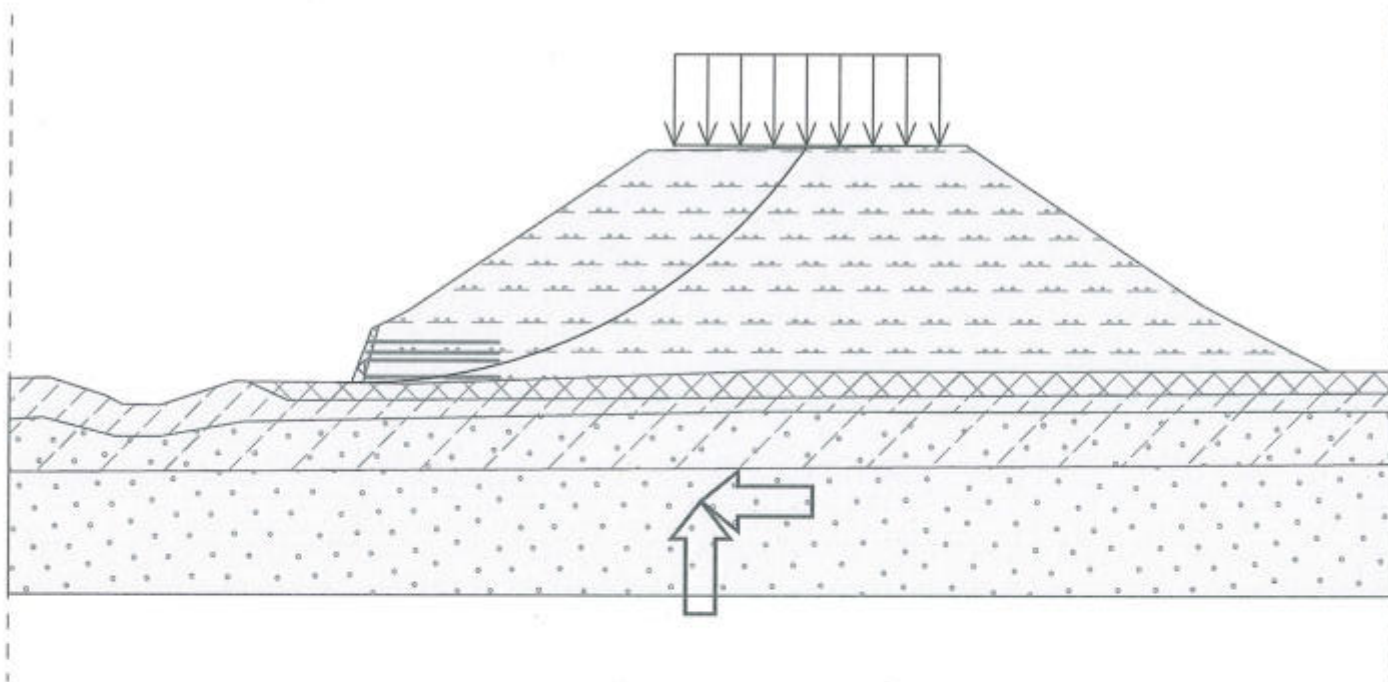
Sum of passive forces : $F_p = 692.73$ kN/m

Sliding moment : $M_a = 13486.06$ kNm/m

Resisting moment : $M_p = 14277.22$ kNm/m

Utilization : 94.5 %

Slope stability ACCEPTABLE



2.3 Rambleu km 1+860

2.3.1 Calcul stabilitate si tasare

Slope stability analysis

Standard - EN 1997 - DA3

Stability analysis

Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
Partial factor on internal friction :	$\gamma_\phi =$	1.25 [-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.25 [-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40 [-]	

Soil parameters

M. umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 18.00^\circ$
 Cohesion of soil : $c_{ef} = 22.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Argila

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 12.00^\circ$
 Cohesion of soil : $c_{ef} = 35.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Nisip

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 28.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Assigning and surfaces

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude	
								q, q ₁ , f, F	q ₂ unit
1	strip	permanent	on terrain	x = 25.00	l = 10.00		0.00	26.00	kN/m ²

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters				
Center :	x =	14.88 [m]	Angles :	$\alpha_1 =$ -10.99 [°]
	z =	35.39 [m]		$\alpha_2 =$ 57.15 [°]
Radius :	R =	18.29 [m]		
The slip surface after optimization.				

Slope stability verification (Bishop)

Sum of active forces : $F_a = 558.31$ kN/m

Sum of passive forces : $F_p = 715.33$ kN/m

Sliding moment : $M_a = 10211.44$ kNm/m

Resisting moment : $M_p = 13083.31$ kNm/m

Utilization : 78.0 %

Slope stability ACCEPTABLE

Input data (Stage of construction 2)

Earthquake

Horizontal seismic coefficient : $K_h = 0.10$

Vertical seismic coefficient : $K_v = 0.05$

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters				
Center :	x =	46.07 [m]	Angles :	$\alpha_1 =$ -52.06 [°]
	z =	38.86 [m]		$\alpha_2 =$ 9.62 [°]
Radius :	R =	21.82 [m]		
The slip surface after optimization.				

Slope stability verification (Bishop)

Sum of active forces : $F_a = 702.66$ kN/m

Sum of passive forces : $F_p = 770.30$ kN/m

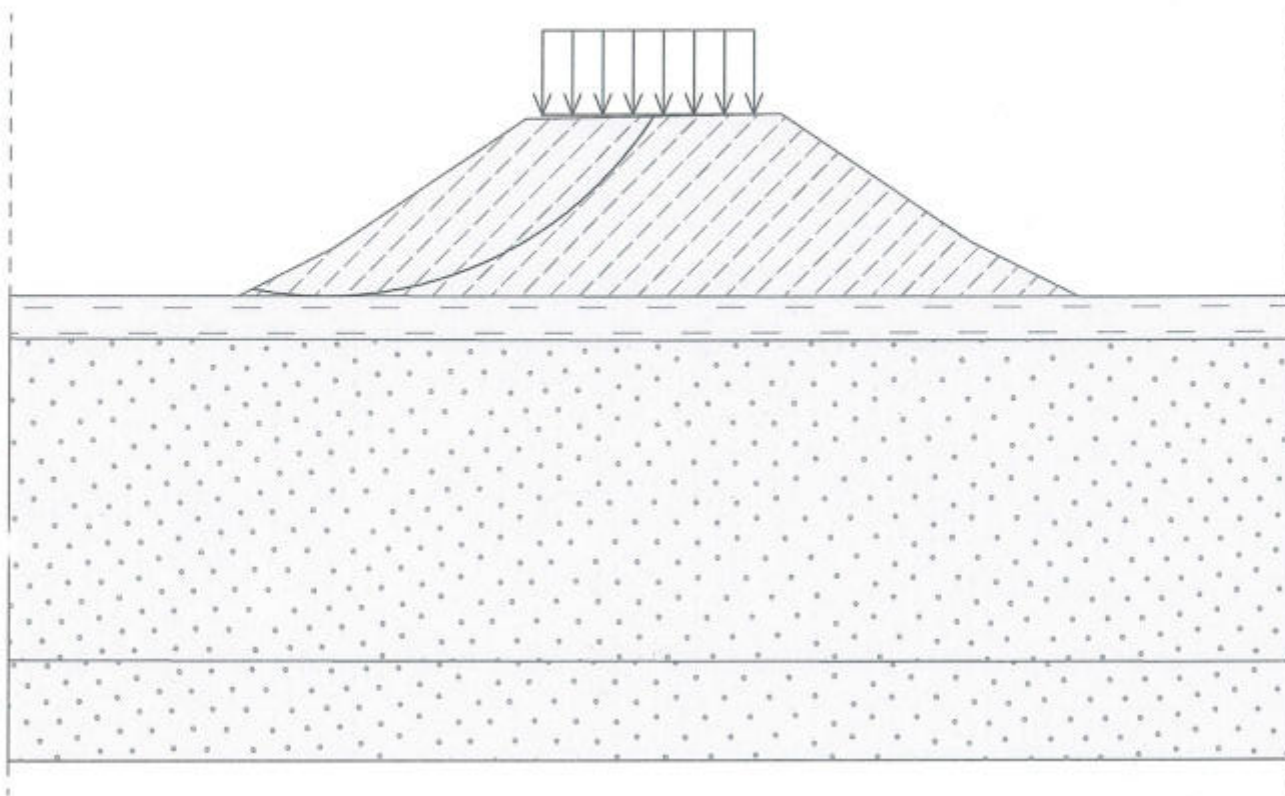
Sliding moment : $M_a = 15332.10$ kNm/m

Resisting moment : $M_p = 16807.89$ kNm/m

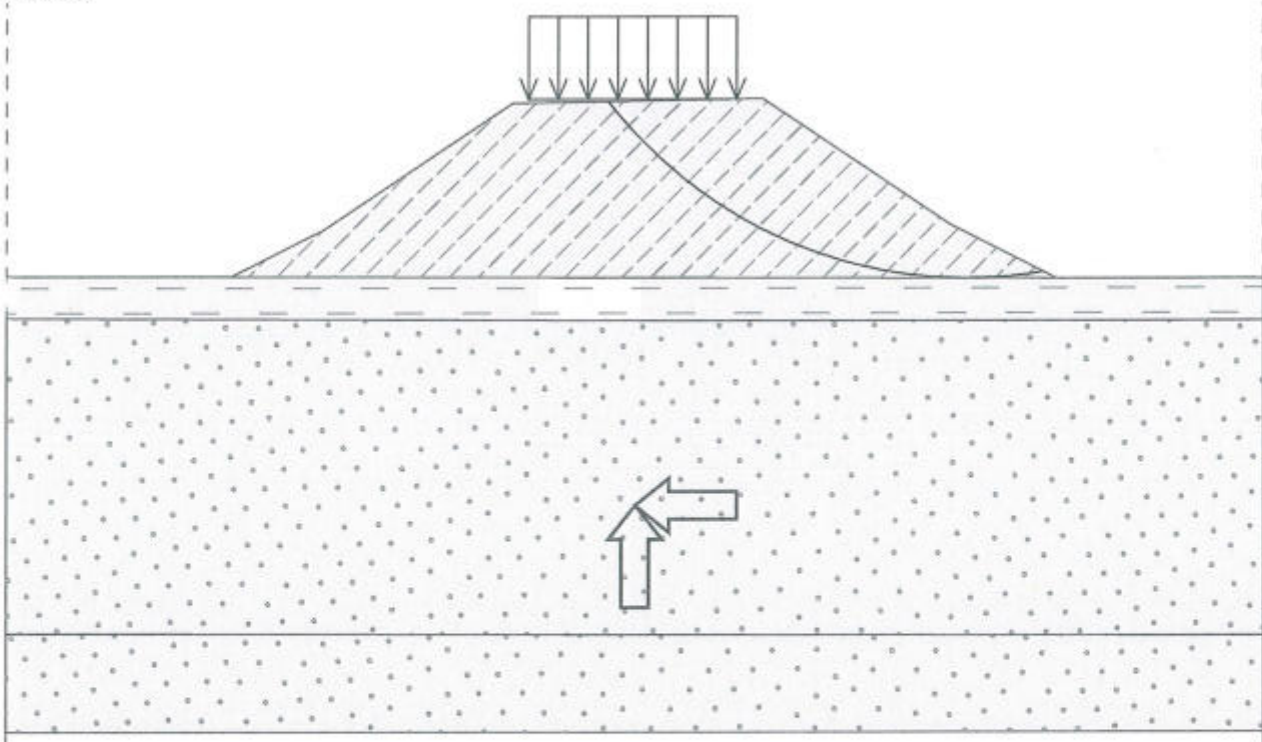
Utilization : 91.2 %

Slope stability ACCEPTABLE

Static



Dinamic



Settlement analysis km 1+860

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Soil parameters

M. Umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 18.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Argila

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 15.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

nisip

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 25.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Surcharge

No.	Surcharge		Type	Location	Origin	Length	Width	Distance from axes	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 25.00	l = 10.00			26.00		kN/m ²

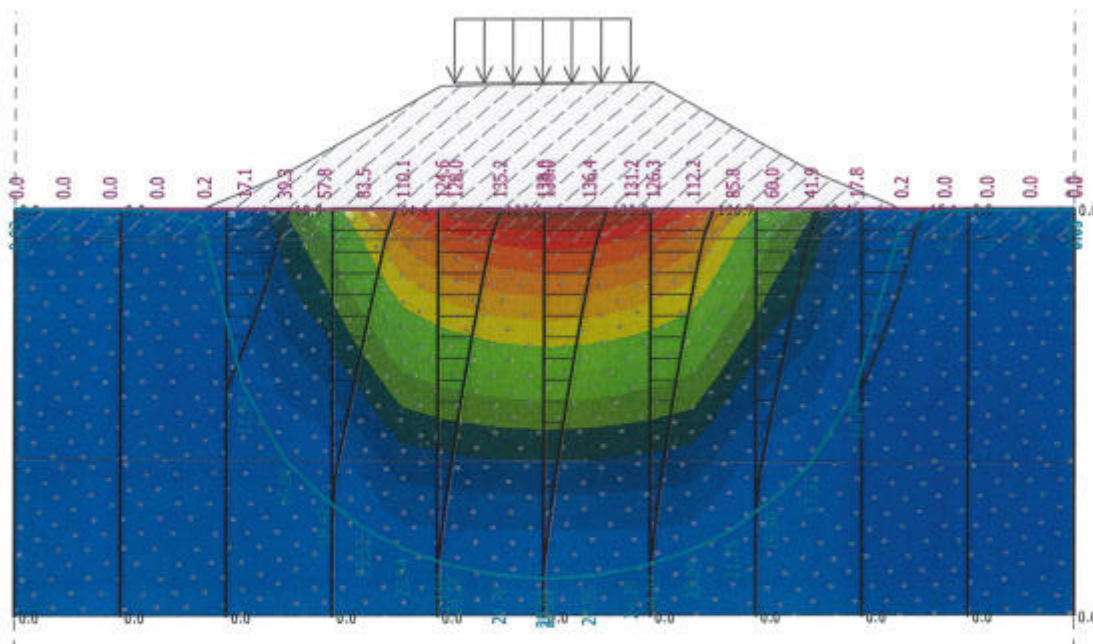
Surcharges

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 138.0 mm

Maximum depth of influence zone = 25.03 m



2.4 Rambleu km 7+140

2.4.1 Calcul stabilitate si tasare

Slope stability analysis KM 7+140

Settings

Standard - EN 1997 - DA3

Stability analysis

Earthquake analysis : Standard

Verification methodology : according to EN 1997

Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	

Partial factors for soil parameters (M)		
Permanent design situation		
Partial factor on internal friction :	$\gamma_\phi =$	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40 [-]

Soil parameters

M. umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 18.00^\circ$
 Cohesion of soil : $c_{ef} = 22.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Perna balast

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 15.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

A. maronie

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 10.00^\circ$
 Cohesion of soil : $c_{ef} = 18.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

N. argilos

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 19.00^\circ$
 Cohesion of soil : $c_{ef} = 15.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Nisip

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 28.00^\circ$
Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude		
								q, q ₁ , f, F	q ₂	unit
1	strip	permanent	on terrain	x = 25.00	l = 10.00		0.00	26.00		kN/m ²

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters					
Center :	x =	14.77 [m]	Angles :	$\alpha_1 =$	-23.44 [°]
	z =	21.91 [m]		$\alpha_2 =$	66.06 [°]
Radius :	R =	18.21 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : $F_a = 876.17 \text{ kN/m}$
Sum of passive forces : $F_p = 1061.77 \text{ kN/m}$
Sliding moment : $M_a = 15955.00 \text{ kNm/m}$
Resisting moment : $M_p = 19334.82 \text{ kNm/m}$
Utilization : 82.5 %

Slope stability ACCEPTABLE

Earthquake

Horizontal seismic coefficient : $K_h = 0.10$
Vertical seismic coefficient : $K_v = 0.05$

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters					
Center :	x =	14.84 [m]	Angles :	$\alpha_1 =$	-23.22 [°]
	z =	22.14 [m]		$\alpha_2 =$	65.56 [°]
Radius :	R =	18.43 [m]			
The slip surface after optimization.					

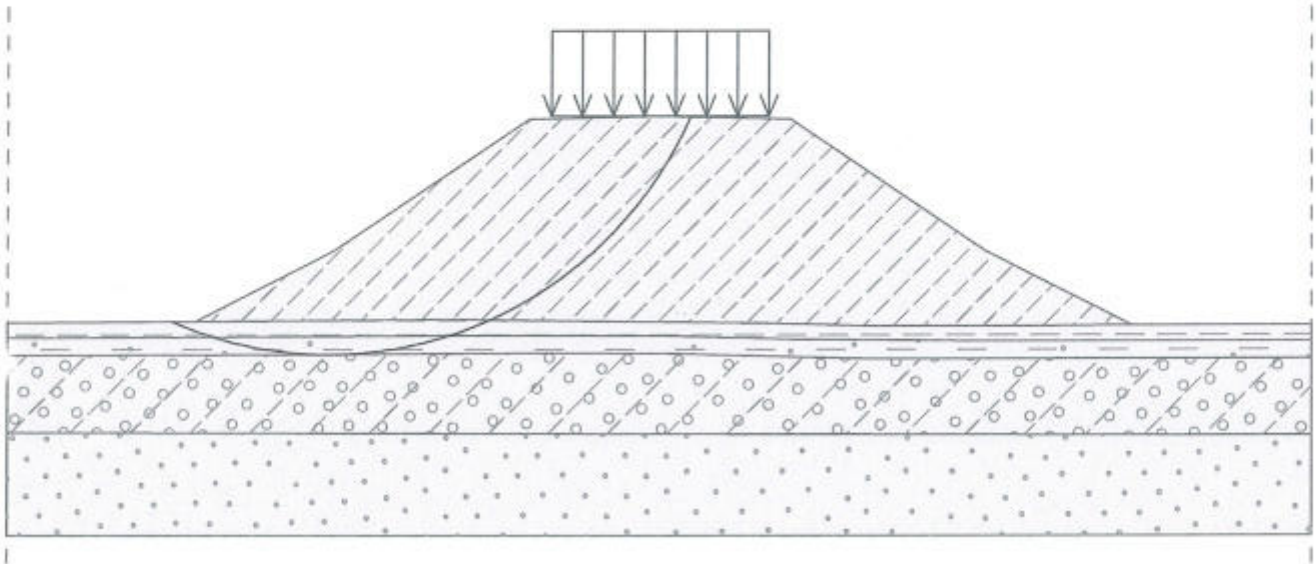
Slope stability verification (Bishop)

Sum of active forces : $F_a = 1003.80 \text{ kN/m}$
Sum of passive forces : $F_p = 1020.43 \text{ kN/m}$

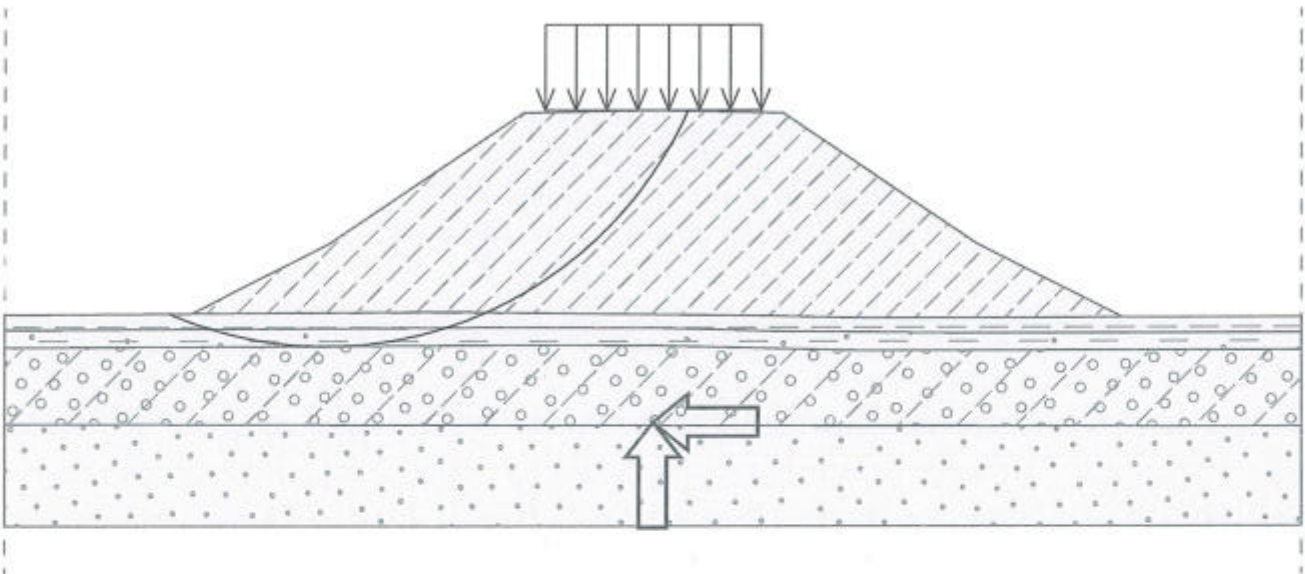
Sliding moment : $M_a = 18500.11 \text{ kNm/m}$
Resisting moment : $M_p = 18806.51 \text{ kNm/m}$
Utilization : 98.4 %

Slope stability ACCEPTABLE

Static



Dinamic



Settlement analysis km 7+140

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Soil parameters

M umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Perna balast

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

A maronie

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 10.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

N argilos

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 18.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Nisip

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Surcharge

No.	Surcharge		Type	Location	Origin	Length	Width	Distance from axes	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 25.00	l = 10.00			26.00		kN/m ²

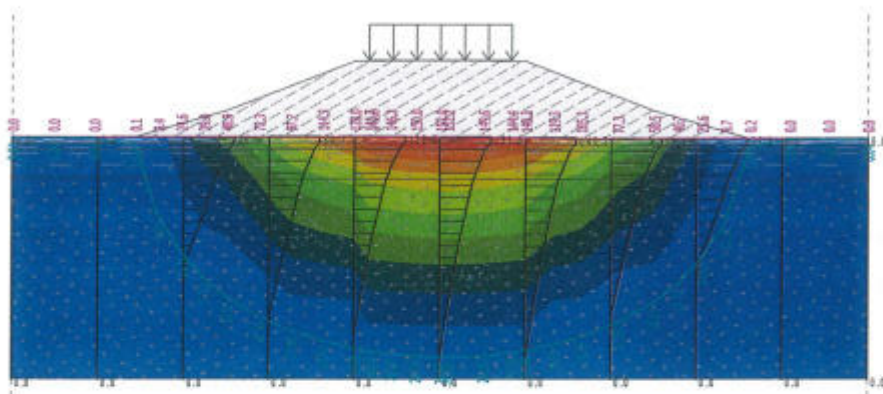
Results (Stage of construction 2)

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 152.2 mm

Maximum depth of influence zone = 26.87 m



2.5 Rambleu km 20+860

2.5.1 Calcul stabilitate si tasare

Slope stability analysis KM 20+860

Input data

Settings

Standard - EN 1997 - DA3

Stability analysis

Earthquake analysis : Standard

Verification methodology : according to EN 1997

Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
Partial factor on internal friction :	$\gamma_\phi =$	1.25 [-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.25 [-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40 [-]	

Partial factors on actions (A)					
Seismic design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.00 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.00 [-]	0.00 [-]	1.00 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	

Partial factors for soil parameters (M)			
Seismic design situation			
Partial factor on internal friction :	$\gamma_\phi =$	1.25 [-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.25 [-]	

Partial factors for soil parameters (M)		
Seismic design situation		
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40 [-]

Soil parameters

M umplutura

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 18.00^\circ$
Cohesion of soil :	$c_{ef} = 22.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

A. maronie

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 15.00^\circ$
Cohesion of soil :	$c_{ef} = 30.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

Nisip

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 28.00^\circ$
Cohesion of soil :	$c_{ef} = 2.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude	
								q, q ₁ , f, F	unit
1	strip	permanent	on terrain	x = 14.00	l = 10.00		0.00	26.00	kN/m ²

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters				
Center :	x =	8.59 [m]	Angles :	$\alpha_1 = -9.92$ [°]
	z =	14.77 [m]		$\alpha_2 = 54.65$ [°]
Radius :	R =	10.68 [m]		

The slip surface after optimization.

Slope stability verification (Bishop)

Sum of active forces :	$F_a = 213.75 \text{ kN/m}$
Sum of passive forces :	$F_p = 338.45 \text{ kN/m}$
Sliding moment :	$M_a = 2282.90 \text{ kNm/m}$
Resisting moment :	$M_p = 3614.67 \text{ kNm/m}$
Utilization :	63.2 %

Slope stability ACCEPTABLE

Earthquake

Horizontal seismic coefficient : $K_h = 0.15$
Vertical seismic coefficient : $K_v = 0.07$

Settings of the stage of construction

Design situation : seismic

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

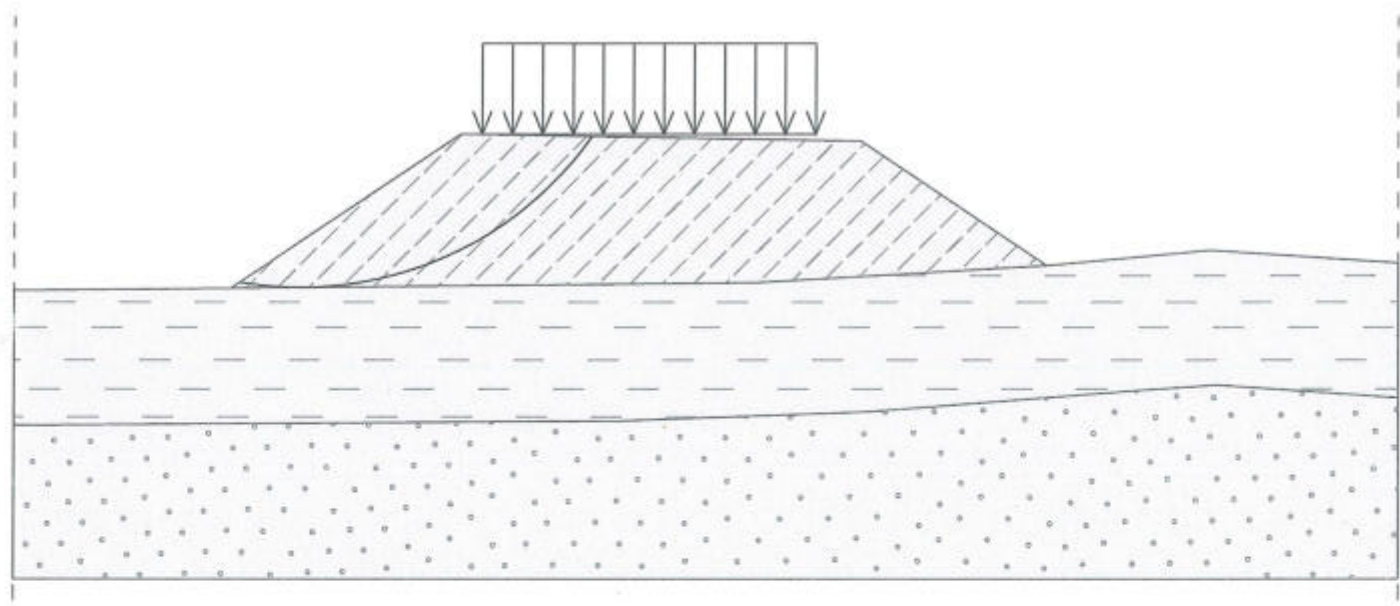
Slip surface parameters				
Center :	x =	8.54 [m]	Angles :	$\alpha_1 =$ -8.25 [°]
	z =	16.86 [m]		$\alpha_2 =$ 49.55 [°]
Radius :	R =	12.77 [m]		
The slip surface after optimization.				

Slope stability verification (Bishop)

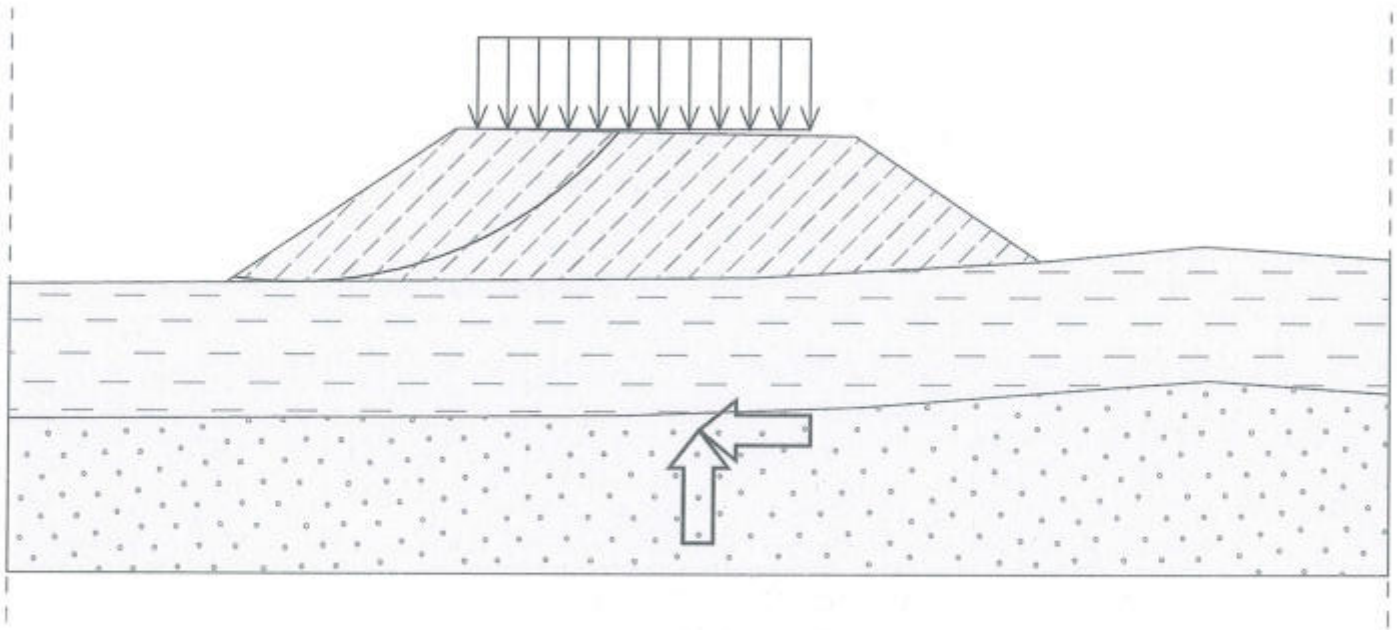
Sum of active forces : $F_a = 259.49$ kN/m
Sum of passive forces : $F_p = 347.78$ kN/m
Sliding moment : $M_a = 3313.69$ kNm/m
Resisting moment : $M_p = 4441.19$ kNm/m
Utilization : 74.6 %

Slope stability ACCEPTABLE

STATIC



DINAMIC



Settlement analysis KM 20+860

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Interface

Soil parameters

M. umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

A maronie

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 14.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

nisip

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 25.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Input data (Stage of construction 2)

Embankment interface

Assigning and surfaces

Surcharge

No.	Surcharge		Type	Location	Origin	Length	Width	Distance from axes	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 14.00	l = 10.00		y [m]	26.00		kN/m ²

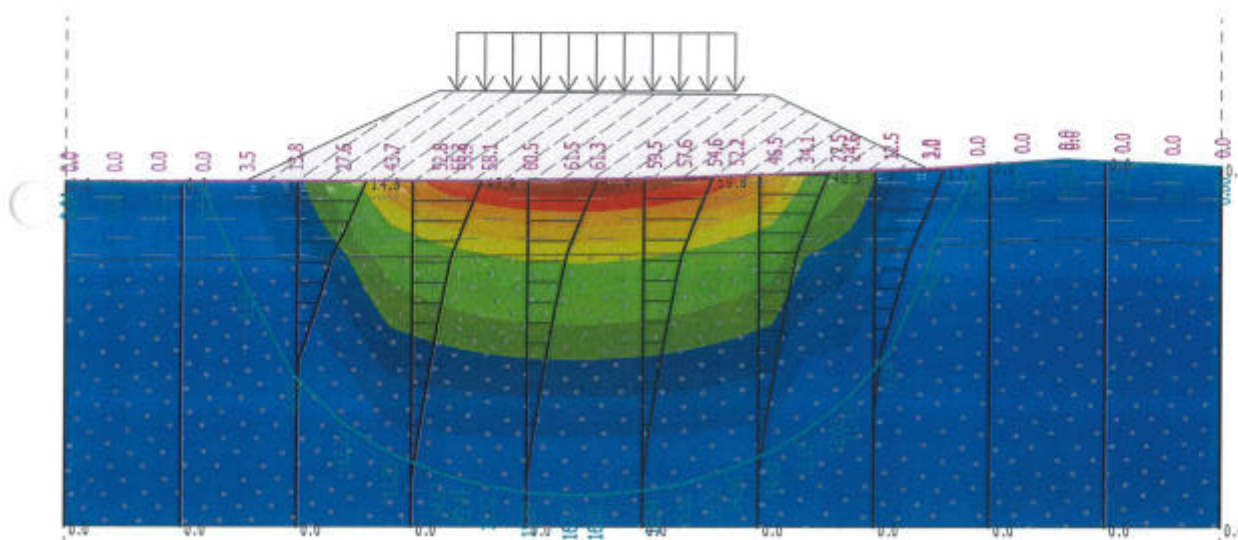
Results (Stage of construction 2)

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 61.5 mm

Maximum depth of influence zone = 16.08 m



2.6 Rambleu km km 24+720

2.6.1 Calcul stabilitate si tasare

Slope stability analysis KM 24+720

Settings

Standard - EN 1997 - DA3

Stability analysis

Earthquake analysis : Standard

Verification methodology : according to EN 1997

Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$			1.00 [-]	
Partial factors for soil parameters (M)					
Permanent design situation					
Partial factor on internal friction :			$\gamma_\phi =$	1.25 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
Partial factor on effective cohesion :	$\gamma_c =$	1.25	[-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.40	[-]

Interface

Soil parameters

M. umplutura

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 18.00^\circ$
Cohesion of soil :	$c_{ef} = 22.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

Perna balast

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 45.00^\circ$
Cohesion of soil :	$c_{ef} = 15.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

A.N. prafoasa

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 15.00^\circ$
Cohesion of soil :	$c_{ef} = 30.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

N. argilos

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 25.00^\circ$
Cohesion of soil :	$c_{ef} = 13.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

A. prafoasa

Unit weight :	$\gamma = 18.00 \text{ kN/m}^3$
Stress-state :	effective
Angle of internal friction :	$\varphi_{ef} = 25.00^\circ$
Cohesion of soil :	$c_{ef} = 13.00 \text{ kPa}$
Saturated unit weight :	$\gamma_{sat} = 19.00 \text{ kN/m}^3$

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude		
								q, q ₁ , f, F	q ₂	unit
1	strip	permanent	on terrain	x = 22.00	l = 9.00		0.00	26.00		kN/m ²

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters				
Center :	x =	39.21 [m]	Angles :	$\alpha_1 =$ -52.16 [°]
	z =	22.34 [m]		$\alpha_2 =$ 7.99 [°]
Radius :	R =	15.88 [m]		
The slip surface after optimization.				

Slope stability verification (Bishop)

Sum of active forces : $F_a = 348.55$ kN/m

Sum of passive forces : $F_p = 509.74$ kN/m

Sliding moment : $M_a = 5534.96$ kNm/m

Resisting moment : $M_p = 8094.72$ kNm/m

Utilization : 68.4 %

Slope stability ACCEPTABLE

Earthquake

Horizontal seismic coefficient : $K_h = 0.10$

Vertical seismic coefficient : $K_v = 0.05$

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters					
Center :	x =	39.23 [m]	Angles :	$\alpha_1 =$	-51.59 [°]
	z =	22.66 [m]		$\alpha_2 =$	7.79 [°]
Radius :	R =	16.20 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : $F_a = 402.64$ kN/m

Sum of passive forces : $F_p = 496.38$ kN/m

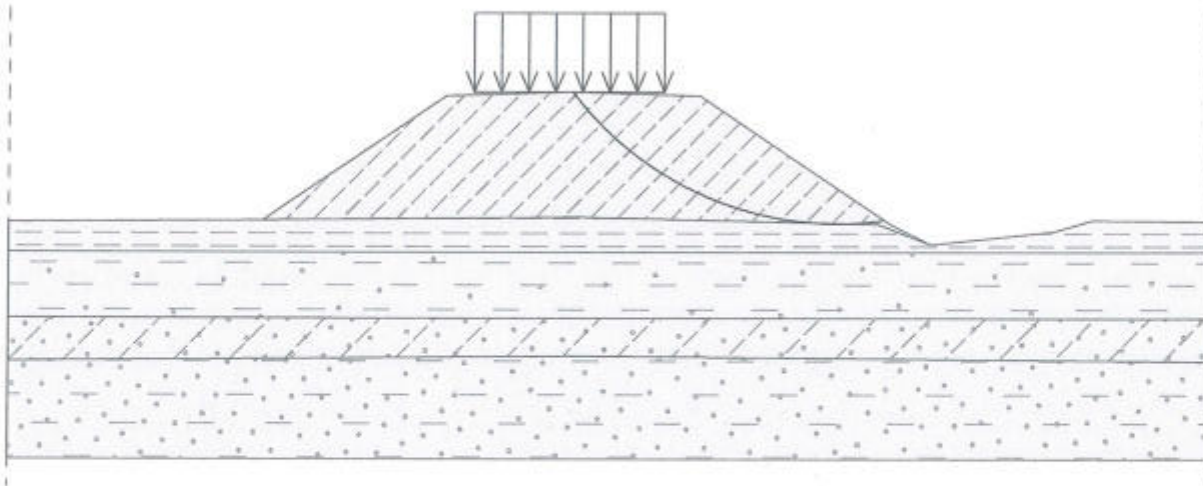
Sliding moment : $M_a = 6522.71$ kNm/m

Resisting moment : $M_p = 8041.29$ kNm/m

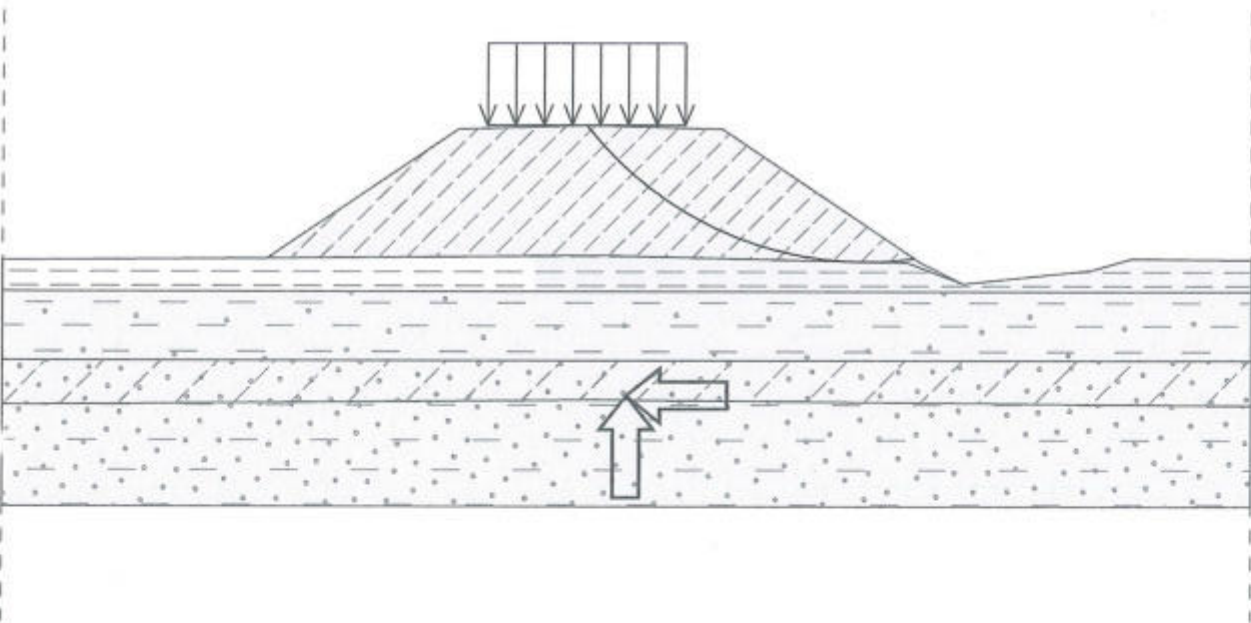
Utilization : 81.1 %

Slope stability ACCEPTABLE

STATIC



DINAMIC



Settlement analysis

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Interface

Soil parameters

M. umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

A.N. prafoasa

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 10.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Perna balast

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 40.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

N. argilos

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 15.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

A. prafoasa

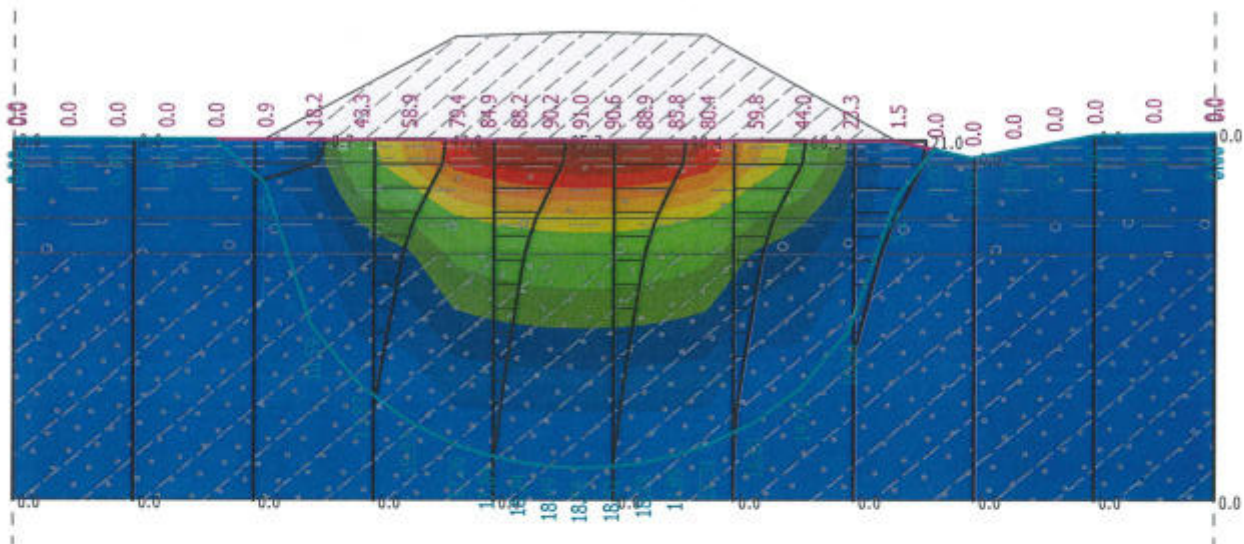
Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 25.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 91.0 mm

Maximum depth of influence zone = 18.58 m



2.7 Rambleu km 0+900

2.7.1 Calcul tasare

Settlement analysis KM 0+900

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Interface

Soil parameters

M umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Mat. Imbunatatit

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 40.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Argila

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 10.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Nisip

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 25.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Surcharge

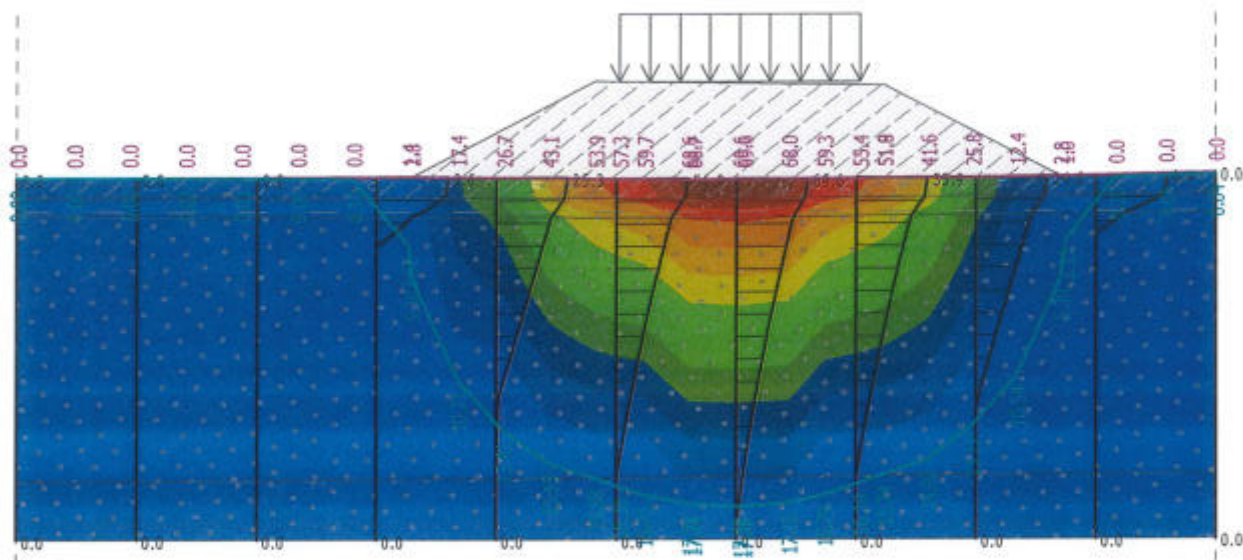
No.	Surcharge		Type	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Distance from axes y [m]	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 25.00	l = 10.00			26.00		kN/m ²

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 69.6 mm

Maximum depth of influence zone = 17.38 m



2.8 Rambleu km 2+740

2.8.1 Calcul tasare

Settlement analysis KM 2+740

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Soil parameters

M.umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

M.imbunatatit

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 40.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

A. nisipoasa

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 8.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Nisip

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 25.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 20.00 \text{ kN/m}^3$

Surcharge

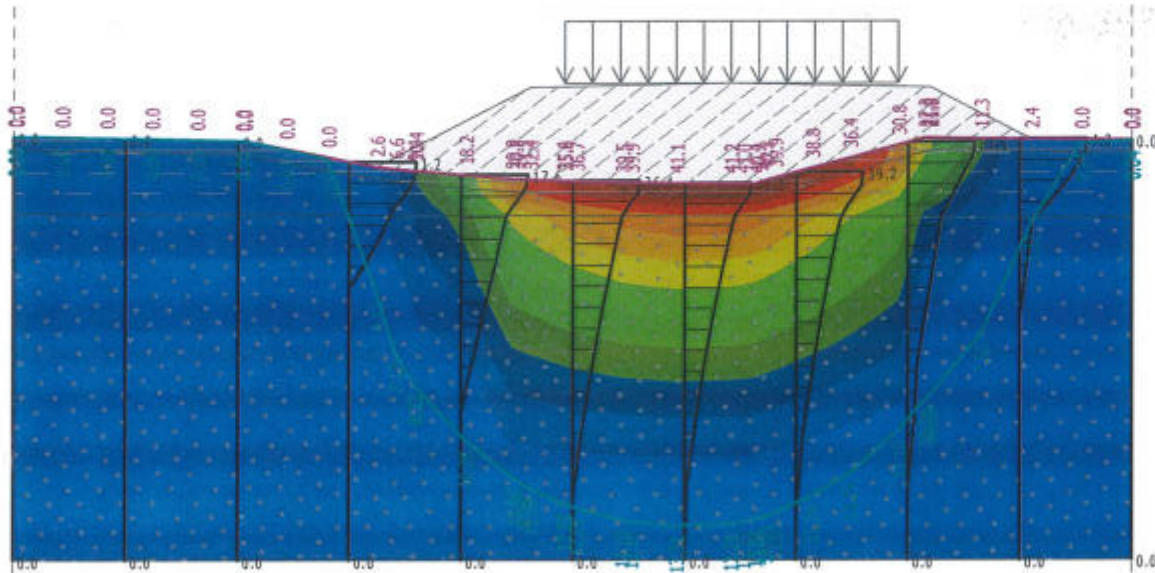
No.	Surcharge		Type	Location	Origin	Length	Width	Distance from axes	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 16.50	l = 10.00			26.00		kN/m ²

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 41.2 mm

Maximum depth of influence zone = 13.31 m



2.9 Rambleu km 8+940

2.9.1 Calcul tasare

Settlement analysis km 8+940

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma, Or
Coeff. of restriction of influence zone : 20.0 [%]

Interface

Soil parameters

M.umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Saltea celulara

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Deseuri constructii

Unit weight : $\gamma = 16.00 \text{ kN/m}^3$
Oedometric modulus : $E_{\text{oed}} = 6.00 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 17.00 \text{ kN/m}^3$

N argilos

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
Oedometric modulus : $E_{\text{oed}} = 16.00 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

A. prafoasa

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Nisip

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 28.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Input data (Stage of construction 2)

Embankment interface

Assigning and surfaces

Surcharge

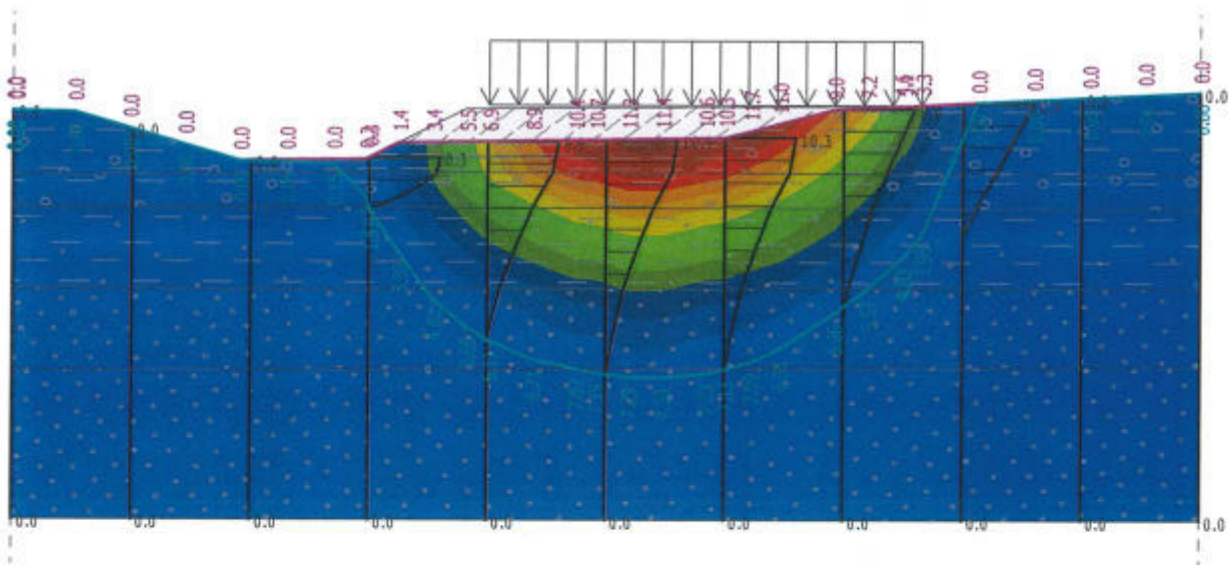
No.	Surcharge		Type	Location	Origin	Length	Width	Distance from axes	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 11.00	l = 10.00			26.00		kN/m ²

Results

Analysis performed, method Analysis using oedometric modulus

Maximum settlement = 11.7 mm

Maximum depth of influence zone = 7.33 m



2.10 Rambleu km 10+960

2.10.1 Calcul tasare

Settlement analysis

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 20.0 [%]

Soil parameters

M. umplutura

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 20.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Blocaj+saltea celulara

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Nisip + pietris

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Oedometric modulus : $E_{\text{oed}} = 25.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 19.00 \text{ kN/m}^3$

Surcharge

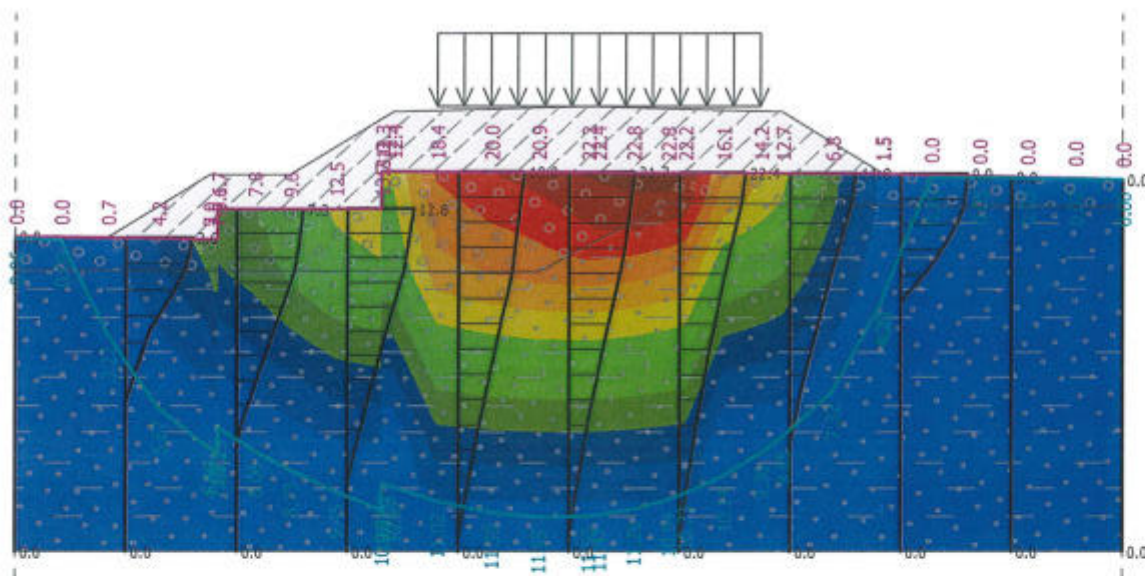
No.	Surcharge		Type	Location	Origin	Length	Width	Distance from axes	Magnitude		
	new	change							q, q ₁ , f, F	q ₂	unit
1	Yes		strip	on terrain	x = 13.00	l = 10.00			26.00		kN/m ²

Results

performed, method Analysis using oedometric modulus

Maximum settlement = 22.8 mm

Maximum depth of influence zone = 11.55 m



By Pass Timisoara TR2 wall - km 1+536 seismic condition

Tensar
Structural Systems

Steel Mesh Panel
System



IMPORTANT NOTES

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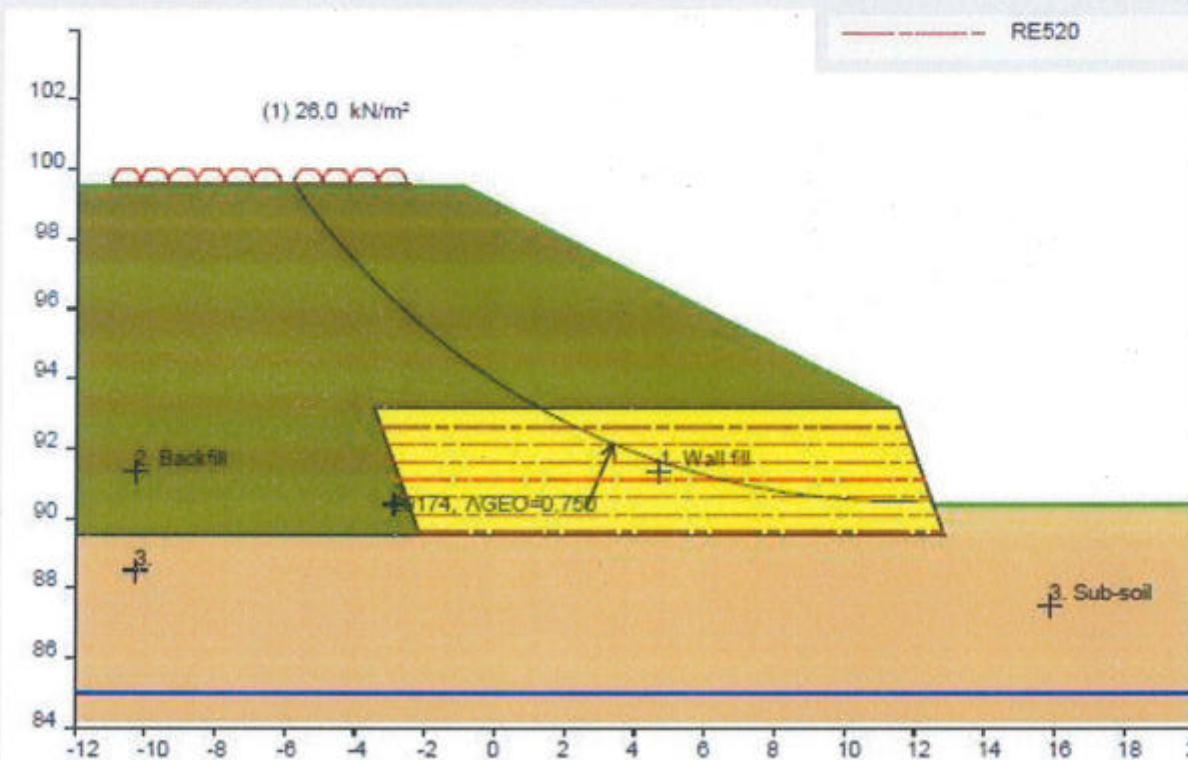
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Method of analysis

The calculation methods used to create this Application Suggestion Application Suggestion is the simplified method of slices using a circular slip surface following the method given by Bishop (Géotechnique, Vol 5, No 1, 1955) modified to take into account the stabilising effect of layers of geogrid reinforcement
Analysis with partial factors defined by EBGE0 2010 (DIN 1054:2010-12) for seismic loading.

Input data and Section
Project:
By Pass Timisoara TR2 wall - km 15+360

 Tensar Structural Systems **Steel Mesh Panel System**

Seismic loading case

All dimensions in metres

Scale 1:200

Soil properties

Soil zone	Drained/ undrained	c'_k (kN/m²)	Φ'_k (°)	$\gamma_{bulk,k}$ (kN/m³)
1, Wall fill	Drained	0,0	33,0 (cv)	18,0
2, Backfill	Drained	35,0	24,0 (cv)	19,6
3, Sub-soil	Drained	35,0	25,0 (cv)	19,0

Soil parameter characteristic values are a cautious estimate of the value affecting the occurrence of the limit state in accordance with Clause 2.4.5.2 (2)P of EN 1997-1:2004, with reference to the National Annex and relevant standards

Surcharges	Load	Load acts from x (m) To x (m)	Load (kN/m²)	Transient/Permanent
	1	-10,972 -2,472	26,00	Transient

x values are measured from X=0

Loads given above are characteristic values, design values are obtained by applying appropriate partial load factors

Reference O-29345

Date 3 Sep 2019

Page 2 of 6

Seismic design data g = acceleration due to gravity	Input	External mechanisms	Internal mechanisms	
	$A_h = 0,20g$	$k_h(\text{ext}) = 0,15g$	$k_h(\text{int}) = 0,30g$	
	$A_v = 0,10g$	$k_v(\text{ext}) = 0,05g$	$k_v(\text{int}) = 0,10g$	
	Vertical accelerations may act either downwards or upwards			
	Factor for importance of structure		γ_I	1,20
	Factor for site topography		S_T	1,0
	Factor for soil conditions at site		S	1,25
	Factor for ductility for internal mechanisms		$r(\text{int})$	1,0
	Factor for ductility for external mechanisms		$r(\text{ext})$	2,0

Note: Where pore water pressures exist, vertical acceleration acts as an undrained loading, producing a change in pore water pressure equal to the change in total stress

Note: Analysis for the static condition must be carried out in a separate calculation and may be more critical than the seismic case

Stability results Moments per linear metre of structure	Circle number	Disturbing moment (kNm/m)	Resisting moment soil (kNm/m)	Resisting moment geogrids (kNm/m)	Λ_{GEO}
	29174	18086	20802	3501	0,750, Down
	25083	17368	20109	3237	0,744, Down
	26417	18150	21039	3325	0,745, Down
	26450	17373	19921	3325	0,747, Down
	26483	16479	18779	3325	0,746, Down
	28968	32991	60913	0	0,542, Down
	29047	8897	16089	0	0,553, Down
	29108	19738	22951	3501	0,746, Down
	30527	18866	21579	3589	0,750, Down
	30560	17957	20394	3589	0,749, Down
	30593	16928	19183	3589	0,743, Down

Applied partial factors As given in DIN 1054:2010-12 and applied to characteristic values to obtain design values	Soil resistance	Drained frictional resistance $\tan \varphi'$	$\gamma_\varphi =$	1,10
		Drained cohesion intercept c'	$\gamma_c =$	1,10
		Undrained shear strength s_u	$\gamma_{su} =$	1,10
		Overall earth resistance	$\gamma_{Re} =$	1,0
	Reinforcement	Tensile strength	$\gamma_M =$	1,20
		Pullout of reinforcement	$\gamma_B =$	1,20
		Sliding on reinforcement	$\gamma_{GL} =$	1,20
	Loads	Slice weight	$\gamma_k =$	1,0
		Permanent applied loads	$\gamma_G =$	1,0
		Transient applied loads	$\gamma_Q =$	1,0
		Accidental loads (seismic)	$\gamma_A =$	1,0

**Further information
relevant to this
Design Analysis**

Further information, specifications and bill of quantities descriptions for this Tensar Earth Retaining Structure are given in the following documents which form part of this Design Analysis

System overview
Installation guide
Case histories

The current versions of these documents may be found by following the website link to "Tensar Documentation" in the Help menu of the TensarSlope program

For program users who do not have a link to the internet contact your nearest Tensar representative or distributor

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Web: www.tensar.co.uk

Detailed input information

The following tables provide the detailed input information used to define the reinforced fill structure including: coordinates of soil lines and water pressure lines (both internal water pressure and external standing water), geogrid design data and geogrid layout.

In all the tables which follow, X and Y are cartesian coordinates in metres, with Y measured vertically upwards, and measured from X = 0 in the horizontal direction and Y = 0 in the vertical direction.

Soil lines

The soil type found beneath each line is indicated in the table below.

Where a facing is associated with any line, this is also indicated in the table below.

Line No.	X ₁ (m)	Y ₁ (m)	X ₂ (m)	Y ₂ (m)	Soil No.	Facing type
1	40,000	90,410	12,532	90,410	3	
2	12,860	89,510	12,532	90,410	1	Steel mesh panel
3	12,532	90,410	11,528	93,170	1	Steel mesh panel
4	11,528	93,170	-0,915	99,510	2	
5	-0,915	99,510	-5,780	99,510	2	
6	-5,780	99,510	-50,000	99,510	2	
7	12,860	89,510	-2,140	89,510	3	
8	-2,140	89,510	-50,000	89,510	3	
9	-2,140	89,510	-3,472	93,170	2	
10	11,528	93,170	-3,472	93,170	1	

Water pressure lines

Pore water pressure at a point is defined according to vertical distance from the following lines:

Line No	X ₁ (m)	Y ₁ (m)	Pressure (kN/m ²)	X ₂ (m)	Y ₂ (m)	Pressure (kN/m ²)
1	-50,000	85,000	0,000	40,000	85,000	0,000

If there is a line above the point examined and none below, then pore pressure is taken to increase hydrostatically with depth below that water pressure line.

If there is a line above the point examined and a line below, then water pressure is interpolated between the pressures on the two lines.

Pressure at a point along a line is determined by linear interpolation

Reinforcement design data

Reinforcement design strength is calculated using the strengths and factors given below

In soil type 1 - Wall fill			Design life (years) seismic		Design temperature (°C) 20	
Tensar Geogrid	Tensile strength (kN/m)	Installation damage factor	Connection factor	Durability factor	Characteristic strength (kN/m)	Sliding coefficient
	R _{B,k0}	A ₂	A ₃	A ₄	R _{B,k}	λ _{GL}
RE520	52,80	1,25	1,00	1,00	42,24	0,85

For the seismic analysis case geogrid design strength is based on the short term tensile strength of the geogrid due to the short duration of loading

Reinforcement layout

Reinforcement level is defined by its Y co-ordinate

Tensar geogrid	Level	Left end	Right end	Length	Coverage	Pullout interaction factor	Fixed at	
	Y (m)	X (m)	X (m)	(m)	(%)	λ_B	left	right
RE520	89,610	-2,176	12,824	15,000	100	0,85	No	Yes
RE520	90,110	-2,358	12,642	15,000	100	0,85	No	Yes
RE520	90,610	-2,540	12,459	14,999	100	0,85	No	Yes
RE520	91,110	-2,722	12,277	14,999	100	0,85	No	Yes
RE520	91,610	-2,904	12,095	14,999	100	0,85	No	Yes
RE520	92,110	-3,086	11,914	15,000	100	0,85	No	Yes
RE520	92,610	-3,268	11,732	15,000	100	0,85	No	Yes

By Pass Timisoara TR2 wall - km 1+536 static condition

Tensar
Structural Systems

Steel Mesh Panel
System



IMPORTANT NOTES

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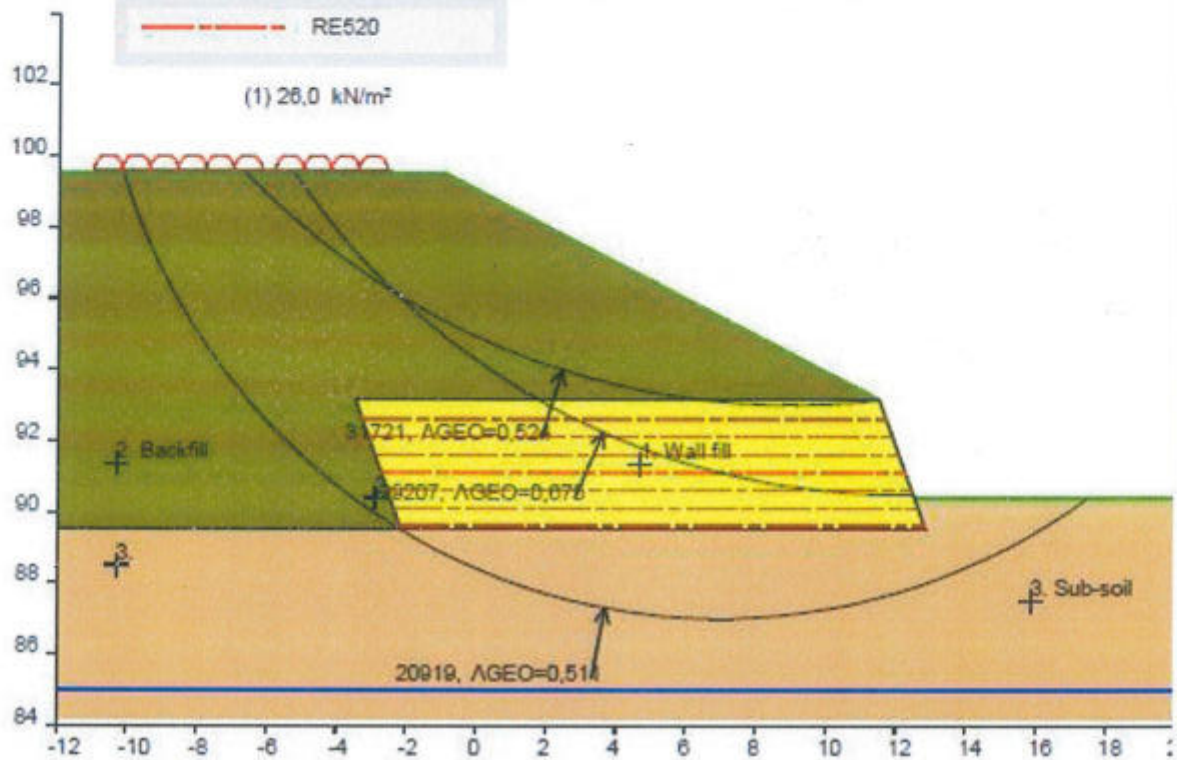
Method of analysis

The calculation methods used to create this Application Suggestion Application Suggestion is the simplified method of slices using a circular slip surface following the method given by Bishop (Géotechnique, Vol 5, No 1, 1955) modified to take into account the stabilising effect of layers of geogrid reinforcement
Analysis with partial factors defined by EBGE0 2010 (DIN 1054:2010-12) for normal loading.

Input data and Section

Project:

By Pass Timisoara TR2 wall - km 15+360



Tensor Structural Systems Steel Mesh Panel System

Normal loading case

All dimensions in metres

Scale 1:200

Soil properties

Soil zone	Drained/ undrained	c'_k (kN/m²)	Φ'_k (°)	$\gamma_{bulk,k}$ (kN/m³)
1, Wall fill	Drained	0,0	33,0 (cv)	18,0
2, Backfill	Drained	35,0	24,0 (cv)	19,6
3, Sub-soil	Drained	35,0	25,0 (cv)	19,0

Soil parameter characteristic values are a cautious estimate of the value affecting the occurrence of the limit state in accordance with Clause 2.4.5.2 (2)P of EN 1997-1:2004, with reference to the National Annex and relevant standards

Surcharges	Load	Load acts from x (m) To x (m)	Load (kN/m²)	Transient/Permanent
1	-10,972	-2,472	26,00	Transient

x values are measured from X=0

Loads given above are characteristic values, design values are obtained by applying appropriate partial load factors

Stability results Moments per linear metre of structure	Circle number	Disturbing moment (kNm/m)	Resisting moment soil (kNm/m)	Resisting moment geogrids (kNm/m)	Λ_{GEO}
	29207	12134	16552	1426	0,675
	20919	20916	40946	0	0,511
	22477	10591	14587	1247	0,669
	23823	10564	14492	1283	0,670
	25181	10491	14322	1319	0,671
	26483	11601	15955	1355	0,670
	26516	11005	15035	1355	0,671
	30580	12663	17367	1462	0,673
	31721	8492	16206	0	0,524
	31914	13196	18141	1498	0,672
	31947	12538	17129	1498	0,673

Applied partial factors As given in DIN 1054:2010-12 and applied to characteristic values to obtain design values	Soil resistance	Drained frictional resistance $\tan \phi'$	$Y_\phi =$	1,25
		Drained cohesion intercept c'	$Y_c =$	1,25
		Undrained shear strength s_u	$Y_{su} =$	1,25
		Overall earth resistance	$Y_{Re} =$	1,0
	Reinforcement	Tensile strength	$Y_M =$	1,40
		Pullout of reinforcement	$Y_B =$	1,40
		Sliding on reinforcement	$Y_{GL} =$	1,40
	Loads	Slice weight	$Y_k =$	1,0
		Permanent applied loads	$Y_G =$	1,0
		Transient applied loads	$Y_Q =$	1,30
		Accidental loads (seismic)	$Y_A =$	1,0

Further information relevant to this Design Analysis	Further information, specifications and bill of quantities descriptions for this Tensar Earth Retaining Structure are given in the following documents which form part of this Design Analysis	System overview Installation guide Case histories
	The current versions of these documents may be found by following the website link to "Tensar Documentation" in the Help menu of the TensarSlope program	
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Detailed input information

The following tables provide the detailed input information used to define the reinforced fill structure including: coordinates of soil lines and water pressure lines (both internal water pressure and external standing water), geogrid design data and geogrid layout.

In all the tables which follow, X and Y are cartesian coordinates in metres, with Y measured vertically upwards, and measured from X = 0 in the horizontal direction and Y = 0 in the vertical direction.

Soil lines

The soil type found beneath each line is indicated in the table below.

Where a facing is associated with any line, this is also indicated in the table below.

Line No.	X ₁ (m)	Y ₁ (m)	X ₂ (m)	Y ₂ (m)	Soil No.	Facing type
1	40,000	90,410	12,532	90,410	3	Steel mesh panel
2	12,860	89,510	12,532	90,410	1	
3	12,532	90,410	11,528	93,170	1	
4	11,528	93,170	-0,915	99,510	2	
5	-0,915	99,510	-5,780	99,510	2	
6	-5,780	99,510	-50,000	99,510	2	
7	12,860	89,510	-2,140	89,510	3	
8	-2,140	89,510	-50,000	89,510	3	
9	-2,140	89,510	-3,472	93,170	2	
10	11,528	93,170	-3,472	93,170	1	

Water pressure lines

Pore water pressure at a point is defined according to vertical distance from the following lines:

Line No	X ₁ (m)	Y ₁ (m)	Pressure (kN/m ²)	X ₂ (m)	Y ₂ (m)	Pressure (kN/m ²)
1	-50,000	85,000	0,000	40,000	85,000	0,000

If there is a line above the point examined and none below, then pore pressure is taken to increase hydrostatically with depth below that water pressure line.

If there is a line above the point examined and a line below, then water pressure is interpolated between the pressures on the two lines.

Pressure at a point along a line is determined by linear interpolation

Reinforcement design data

Reinforcement design strength is calculated using the strengths and factors given below

In soil type 1 - Wall fill			Design life (years) 120		Design temperature (°C) 20	
Tensar Geogrid	Creep rupture strength (kN/m)	Installation damage factor	Connection factor	Durability factor	Characteristic strength (kN/m)	Sliding coefficient
	R _{B,k1}	A ₂	A ₃	A ₄	R _{B,k}	λ _{GL}
RE520	25,10	1,25	1,00	1,00	20,08	0,85

Reinforcement layout

Reinforcement level is defined by its Y co-ordinate

Tensar geogrid	Level	Left end	Right end	Length	Coverage	Pullout interaction factor	Fixed at	
	Y (m)	X (m)	X (m)	(m)	(%)	λ_g	left	right
RE520	89,610	-2,176	12,824	15,000	100	0,85	No	Yes
RE520	90,110	-2,358	12,642	15,000	100	0,85	No	Yes
RE520	90,610	-2,540	12,458	14,999	100	0,85	No	Yes
RE520	91,110	-2,722	12,277	14,999	100	0,85	No	Yes
RE520	91,610	-2,904	12,095	14,999	100	0,85	No	Yes
RE520	92,110	-3,086	11,914	15,000	100	0,85	No	Yes
RE520	92,610	-3,268	11,732	15,000	100	0,85	No	Yes

Project:**Centura Timisoara
km 5+494 H=7.65m**

Calcul este realizat pe baza datelor primite de la beneficiar

**Tensar
Structural Systems****Custom Modular
Block System**

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**Method of
analysis**

The calculation method used to create this Tensar Software Output is two-part wedge reinforced soil retaining wall design method with partial factors defined by EBGE0 2010 (DIN 1054:2010-12) for normal BS-P loading and seismic BS-A loading.

Reference

km 5+494 H=7.65m

Date

19 Dec 2019

Page

1 of 16

Seismic design data $a =$ acceleration due to gravity	Input	External mechanisms	Internal mechanisms
	$A_h = 0.2g$	$k_E(\text{ext}) = 0.15g$	$k_h(\text{int}) = 0.3g$
	$A_v = 0.1g$	$k_v(\text{ext}) = 0.049g$	$k_v(\text{int}) = 0.099g$
	Vertical accelerations may act either downwards or upwards		
	Factor for importance of structure		$\gamma_I = 1.2$
	Factor for site topography		$S_T = 1.0$
	Factor for soil conditions at site		$S = 1.25$
	Factor for ductility for internal mechanisms		$r(\text{int}) = 1.0$
	Factor for ductility for external mechanisms		$r(\text{ext}) = 2.0$

Surcharges	No	Load acts from x (m)	To x (m)	Load (kN/m ²)	Transient/Permanent
	1	2.40	10.00	20	Transient

x coordinates are measured from the top of the wall.

Unit loads given above are characteristic values, design values are obtained by applying appropriate partial load factors to the resulting actions.

Water pressure data	Location	Height of water level above datum (m)	r_u
	In front of structure	No water pressures	
	Within fill	No water pressures	NA

Verification of external stability	Mechanism	Result	Max/Min	Critical case	OK?
	Eccentricity	$\Lambda_{GLS} = 0.66$	1.0 max	Seismic,	OK
	Sliding on base	0.593	1.0 min	Seismic	OK
	Bearing	0.81	1.0 min	Seismic, max. OT	OK

Verification of internal stability	Mechanism	OK?	Mechanism	OK?
	Wedge check Λ_{GEO-3}	OK	Internal sliding Λ_{GEO-3}	OK

Reinforcement layout Starting and finishing levels are related to datum	Tensar Geogrid	No of layers	Starting level (m)	Vertical spacing (m)	Finishing level (m)	Coverage (%)	Λ_B
	RE520	12	2.40	0.45	7.35	100	0.85
	RE560	4	0.60	0.45	1.05	100	0.85
	RE560	1	0.15	-	-	100	0.85

Reference	km 5+494 H=7.65m	Date	19 Dec 2019	Page	3 of 16
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Partial load factors applied to actions As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values	Limit state for Normal Loading			GEO-2	GEO-3	EQU
	Action		Factor	External	Internal	All
	Weight of facing	UNF	γ_{face}	1.35	1.0	1.1
		FAV	$\gamma_{\text{face,fav}}$	1.0	1.0	0.9
	Weight of reinforced fill	UNF	γ_{soil}	1.35	1.0	1.1
		FAV	$\gamma_{\text{soil,fav}}$	1.0	1.0	0.9
	DL above reinforced fill	UNF	γ_G	1.35	1.0	1.1
		FAV	$\gamma_{G,\text{fav}}$	1.0	1.0	0.9
	LL above reinforced fill	UNF	γ_Q	1.5	1.3	1.5
		FAV	$\gamma_{Q,\text{fav}}$	0.0	0.0	0.0
	Earth pressure from soil	UNF	γ_{soil}	1.35	1.0	1.1
		FAV	$\gamma_{\text{soil,fav}}$	1.0	1.0	0.9
	Earth pressure from DL	UNF	γ_G	1.35	1.0	1.1
		FAV	$\gamma_{G,\text{fav}}$	1.0	1.0	0.9
	Earth pressure from LL	UNF	γ_Q	1.5	1.3	1.5
		FAV	$\gamma_{Q,\text{fav}}$	1.0	1.0	1.0
	Water pressure	UNF	γ_W	1.0	1.0	1.0
		FAV	$\gamma_{W,\text{fav}}$	1.0	1.0	1.0
	Accidental loads	UNF	γ_A	NA	NA	NA
		FAV	$\gamma_{A,\text{fav}}$	NA	NA	NA

Partial material and resistance factors As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values	Limit state for Normal Loading			GEO-2	GEO-3	EQU
	Material parameter		Factor	External	Internal	All
	Friction angle of soil	S1	$\gamma_{\phi 1}$	1.0	1.25	1.0
		S2	$\gamma_{\phi 2}$	1.0	1.25	1.0
		S3	$\gamma_{\phi 3}$	1.0	1.25	1.0
	Cohesion intercept of soil	S1	γ_{c1}	1.0	1.25	1.0
		S2	γ_{c2}	1.0	1.25	1.0
		S3	γ_{c3}	1.0	1.25	1.0
	Undrained shear strength	S3	γ_{Cu}	1.0	1.25	1.0
	Geogrid strength long term		γ_M	NA	1.4	NA
	Geogrid strength short term		γ_M	NA	NA	NA
	Pullout interaction factor		γ_{Her}	NA	1.4	NA
	Sliding interaction factor		γ_{GL1-3}	1.1	1.0	NA
	Facing connection strength		γ_B	NA	1.4	NA
	Sliding through facing		γ_{itace}	NA	1.1	NA
	Bearing resistance		γ_{Rv}	1.4	NA	NA
	Sliding resistance		γ_{Rh}	1.1	1.0	NA

Partial load factors applied to actions
As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values

Limit state for Extreme (Seismic) Loading			GEO-2	GEO-3	EQU
Action		Factor	External	Internal	All
Weight of facing	UNF	γ_{face}	1.1	1.0	1.0
	FAV	$\gamma_{face,fav}$	1.0	1.0	0.95
Weight of reinforced fill	UNF	γ_{soil}	1.1	1.0	1.0
	FAV	$\gamma_{soil,fav}$	1.0	1.0	0.95
DL above reinforced fill	UNF	γ_G	1.1	1.0	1.0
	FAV	$\gamma_{G,fav}$	1.0	1.0	0.95
LL above reinforced fill	UNF	γ_Q	1.1	1.1	1.0
	FAV	$\gamma_{Q,fav}$	0.0	0.0	0.0
Earth pressure from soil	UNF	γ_{soil}	1.1	1.0	1.0
	FAV	$\gamma_{soil,fav}$	1.0	1.0	0.95
Earth pressure from DL	UNF	γ_G	1.1	1.0	1.0
	FAV	$\gamma_{G,fav}$	1.0	1.0	0.95
Earth pressure from LL	UNF	γ_Q	1.1	1.1	1.0
	FAV	$\gamma_{Q,fav}$	1.0	1.0	1.0
Water pressure	UNF	γ_W	1.0	1.0	1.0
	FAV	$\gamma_{W,fav}$	1.0	1.0	1.0
Accidental loads	UNF	γ_A	1.0	1.0	1.0
	FAV	$\gamma_{A,fav}$	1.0	1.0	1.0

Partial material and resistance factors As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values	Limit state for Extreme (Seismic) Loading			GEO-2	GEO-3	EQU
	Material parameter		Factor	External	Internal	All
	Friction angle of soil	S1	$\gamma_{\phi 1}$	1.0	1.1	1.0
		S2	$\gamma_{\phi 2}$	1.0	1.1	1.0
		S3	$\gamma_{\phi 3}$	1.0	1.1	1.0
	Cohesion intercept of soil	S1	γ_{c1}	1.0	1.1	1.0
		S2	γ_{c2}	1.0	1.1	1.0
		S3	γ_{c3}	1.0	1.1	1.0
	Undrained shear strength	S3	γ_{Cu}	1.0	1.0	1.0
	Geogrid strength long term		γ_M	NA	1.0	NA
	Geogrid strength short term		γ_M	NA	1.2	NA
	Pullout interaction factor		γ_{Her}	NA	NA	NA
	Sliding interaction factor		γ_{GL1-3}	1.1	1.0	NA
	Facing connection strength		γ_B	NA	1.2	NA
	Sliding through facing		γ_{face}	NA	1.1	NA
	Bearing resistance		γ_{Rv}	1.2	NA	NA
	Sliding resistance		γ_{Rh}	1.1	1.0	NA

Further information relevant to this Tensar Earth Retention System	Further information, specifications and bill of quantities descriptions for this TensarTechEarth Retaining Structure are given in the following documents which form part of this Design Analysis	System overview Installation guide Case histories
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	For program users who do not have a link to the internet contact your nearest Tensar representative or distributor	Tensar International sro +420 558 711 010 (+420 558 711 010) branna@tensar.cz Web: www.tensar.co.uk

Detailed calculation results

The following tables provide the detailed results from the design Analysis, including geogrid design data, together with both external and internal analysis results.

External stability - characteristic (unfactored) calculated forces			
Note: negative forces are upwards and to the right			
Loading direction	Units	Vertical	Horizontal
Characteristic static force components			
Forces in or above reinforced block:			
Soil mass	kN/m	893.909	0.000
Facing	kN/m	32.509	0.000
Dead loads	kN/m	0.000	0.000
Live loads	kN/m	88.869	0.000
From water pressure on base	kN/m	0.000	0.000
From water pressure on face	kN/m	0.000	0.000
Forces behind reinforced block:			
From soil	kN/m	60.228	156.810
From dead loads	kN/m	0.000	0.000
From live loads	kN/m	20.422	53.170
From water pressure	kN/m	0.000	0.000
Additional characteristic static force components due to seismic loading			
Forces in or above reinforced block:			
Soil mass	kN/m	26.978	81.752
Facing	kN/m	1.609	4.876
Dead loads	kN/m	0.000	0.000
Live loads	kN/m	1.452	4.399
From water pressure on base	kN/m	0.000	0.000
From water pressure on face	kN/m	0.000	0.000
Forces behind reinforced block:			
From soil	kN/m	12.116	31.545
From dead loads	kN/m	0.000	0.000
From live loads	kN/m	2.760	7.185
From water pressure	kN/m	0.000	0.000

Verification of external stability - sliding

Partial load and material factors used are as per the GEO limit state.

Sliding resistance is verified for Load combination B.

Loads given below are design values (factored).

Calculation	Units	Static loading	Seismic loading
Design horizontal driving force	kN/m	201.448	346.260
Design horizontal resisting force	kN/m	594.543	584.163
$\Lambda_{\text{GEO-2}}$ (sliding)		0.490	0.593
Requirement		≤ 1.00	≤ 1.00
OK?		OK	OK

Additional sliding check

For inclined structures an additional sliding check is carried out with the back of the reinforced soil

block defined by a series of steeper lines until the highest $\Lambda_{\text{GEO-2}}$ value is obtained.

Critical inclination of wall back	deg	90.000	89.427
Design horizontal driving force	kN/m	297.087	348.029
Design horizontal resisting force	kN/m	604.745	588.617
$\Lambda_{\text{GEO-2}}$ (sliding)		0.491	0.591
Requirement		≤ 1.00	≤ 1.00
OK?		OK	OK

Verification of external stability - bearing resistance check

Calculations carried using Meyerhof load distribution to take into account eccentricity.

Characteristic bearing resistance is calculated using unfactored loads.

Partial load and material factors used are as per the GEO limit state.

Bearing resistance is verified for Load combination A, Load combination A (max overturning) and Load combination B.

Static load case:

Calculation	Units	Load case A	LCA max overturning	Load case B
Total vertical load on base (unfactored)	kN/m	1096	1013	1007
Total horizontal load on base (unfactored)	kN/m	210	210	210
Total moment on base (unfactored)	kNm/m	198	331	331
Factor N_c		19.324	19.324	19.324
Factor N_q		9.603	9.603	9.603
Factor N_b		3.830	3.830	3.830
Factor i_c		0.613	0.585	0.583
Factor i_q		0.654	0.628	0.626
Factor i_y		0.528	0.498	0.496
Effective length L'	m	5.738	5.446	5.443
Characteristic ultimate bearing capacity	kN/m ²	462	432	430
Design bearing resistance	kN/m	2653	2351	2341
Design applied load	kN/m	1496	1371	1007
$\Lambda_{\text{GEO-2}}$ (bearing resistance)		0.564	0.583	0.430
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Seismic load case (vertical acceleration downwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Total vertical load on base (unfactored)	kN/m	1141	1057	1051
Total horizontal load on base (unfactored)	kN/m	340	335	335
Total moment on base (unfactored)	kNm/m	777	873	873
Factor N_c		19.324	19.324	19.324
Factor N_q		9.603	9.603	9.603
Factor N_b		3.830	3.830	3.830
Factor i_c		0.434	0.404	0.401
Factor i_q		0.493	0.466	0.463
Factor i_v		0.346	0.318	0.316
Effective length L'	m	4.738	4.447	4.439
Characteristic ultimate bearing capacity	kN/m ²	351	320	317
Design bearing resistance	kN/m	1664	1423	1409
Design applied load	kN/m	1250	1158	1051
Λ_{GE0-2} (bearing resistance)		0.752	0.814	0.745
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Seismic load case (vertical acceleration upwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Total vertical load on base (unfactored)	kN/m	1077	995	989
Total horizontal load on base (unfactored)	kN/m	330	325	325
Total moment on base (unfactored)	kNm/m	679	774	774
Factor N_c		19.324	19.324	19.324
Factor N_q		9.603	9.603	9.603
Factor N_b		3.830	3.830	3.830
Factor i_c		0.421	0.390	0.387
Factor i_q		0.481	0.453	0.451
Factor i_v		0.334	0.305	0.302
Effective length L'	m	4.839	4.544	4.536
Characteristic ultimate bearing capacity	kN/m ²	342	310	307
Design bearing resistance	kN/m	1656	1409	1395
Design applied load	kN/m	1186	1097	989
Λ_{GE0-2} (bearing resistance)		0.717	0.778	0.709
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Verification of external stability - eccentricity

Eccentricity is verified for Load combination A, Load combination A (max overturning), Load combination B (all LSEQU), and serviceability (LSSLS).

Static load case:

Calculation	Units	Load case A	LCA max overturning	Load case B
Partial load factors as per the EQU limit state.				
Design vertical load on base	kN/m	1249	1124	908
Design moment on base about centreline	kNm/m	230	430	516
Eccentricity	m	0.184	0.382	0.568
Maximum permitted	m	2.033	2.033	2.033
Λ_{EQU} (eccentricity)		0.091	0.188	0.279
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK
Partial load factors as per the SLS limit state.				
Design vertical load on base	kN/m	987	987	987
Design moment on base about centreline	kNm/m	168	168	168
Eccentricity	m	0.171	0.171	0.171
Maximum permitted	m	1.017	1.017	1.017
Λ_{SLS} (eccentricity)		0.168	0.168	0.168
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Verification of external stability - eccentricity

Seismic load case (vertical acceleration downwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Partial load factors as per the EQU limit state.				
Design vertical load on base	kN/m	1141	1057	1001
Design moment on base about centreline	kNm/m	777	873	886
Eccentricity	m	0.681	0.827	0.885
Maximum permitted	m	2.033	2.033	2.033
Λ_{EQU} (eccentricity)		0.335	0.406	0.435
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK
Partial load factors as per the SLS limit state.				
Design vertical load on base	kN/m	1029	1029	1029
Design moment on base about centreline	kNm/m	694	694	694
Eccentricity	m	0.675	0.675	0.675
Maximum permitted	m	1.017	1.017	1.017
Λ_{SLS} (eccentricity)		0.664	0.664	0.664
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Verification of external stability - eccentricity

Seismic load case (vertical acceleration upwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Partial load factors as per the EQU limit state.				
Design vertical load on base	kN/m	1077	995	940
Design moment on base about centreline	kNm/m	679	774	787
Eccentricity	m	0.631	0.778	0.838
Maximum permitted	m	2.033	2.033	2.033
λ_{EQU} (eccentricity)		0.310	0.383	0.412
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK
Partial load factors as per the SLS limit state.				
Design vertical load on base	kN/m	969	969	969
Design moment on base about centreline	kNm/m	606	606	606
Eccentricity	m	0.626	0.626	0.626
Maximum permitted	m	1.017	1.017	1.017
λ_{SLS} (eccentricity)		0.616	0.616	0.616
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below

Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

Design temperature (°C)			Design life (years)			Limit state	ULS
Tensar geogrid	Creep rupture (kN/m)	Installation damage factor	Connection factor	Durability factor	Tensile resistance factor	Design strength (kN/m)	Sliding coefficient
	$R_{B,k1}$	A_2	A_3	A_4	Y_M	$R_{B,d}$	λ_{GL}
RE520	27.34	1.25	1.0	1.0	1.40	15.62	0.85
RE560	45.63	1.15	1.0	1.0	1.40	28.53	0.85

Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below

Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

Design temperature (°C)		10	Design life (years)		Seismic	Limit state	ULS
Tensar geogrid	Tensile strength	Installation damage factor	Connection factor	Durability factor	Tensile resistance factor	Design strength (kN/m)	Sliding coefficient
	$R_{B,k0}$	A_2	A_3	A_4	V_M	$R_{B,d}$	λ_{GL}
RE520	57.51	1.25	1.0	1.0	1.20	38.34	0.85
RE560	96.62	1.15	1.0	1.0	1.20	70.01	0.85

Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below

Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

Design temperature (°C)			Design life (years)		Limit state		SLS
Tensar geogrid	Load to limit creep strain (kN/m)	Installation damage factor	Connection factor	Durability factor	Tensile resistance factor	Design strength (kN/m)	Sliding coefficient
	$R_{B,k1}$	A_2	A_3	A_4	γ_M	$R_{s,d}$	λ_{GL}
RE520	11.87	1.0	1.0	1.0	1.00	11.87	0.85
RE560	19.94	1.0	1.0	1.0	1.00	19.94	0.85

Connection strength

T_c for each layer of reinforcement is determined for ULS as follows:

For modular block facings, T_c is determined on the basis of block properties and connection test results as follows:

Modular block parameters				Geogrid parameters				
Block length	L_u	0.400	(m)	Type	T_{uu}	A_{cs}	λ_{cs}	T_{cmax}
Block height	H_u	0.150	(m)		(kN/m)	(kN/m)	(°)	(kN/m)
Block width	W_u	0.205	(m)	RE520	45.020	3.000	26.0	22.510
Weight incl. infill	G_u	26.0	kg	RE560	75.630	5.000	26.0	37.820
Dist to CoG	D_u	0.150	(m)					
Inclination of face	α_u	1.0	°					
Max. grid spacing		0.900	(m)					

Note that a partial factor of 1.4 is applied to the connection strength

Grid coordinates

Levels are measured from the datum and horizontal location is measured from the toe of the wall

Tensar geogrid	Level	Left end	Right end	Length	Coverage	Pullout interaction factor λ_B
	(m)	(m)	(m)	(m)	%	
RE520	7.35	0.13	6.23	6.10	100	0.85
RE520	6.90	0.12	6.22	6.10	100	0.85
RE520	6.45	0.12	6.21	6.10	100	0.85
RE520	6.00	0.11	6.20	6.10	100	0.85
RE520	5.55	0.10	6.20	6.10	100	0.85
RE520	5.10	0.09	6.19	6.10	100	0.85
RE520	4.65	0.08	6.18	6.10	100	0.85
RE520	4.20	0.08	6.17	6.10	100	0.85
RE520	3.75	0.07	6.17	6.10	100	0.85
RE520	3.30	0.06	6.16	6.10	100	0.85
RE520	2.85	0.05	6.15	6.10	100	0.85
RE520	2.40	0.05	6.14	6.10	100	0.85
RE560	1.95	0.04	6.13	6.10	100	0.85
RE560	1.50	0.03	6.13	6.10	100	0.85
RE560	1.05	0.02	6.12	6.10	100	0.85
RE560	0.60	0.01	6.11	6.10	100	0.85
RE560	0.15	0.01	6.10	6.10	100	0.85

Internal stability results

For static conditions:

Level:	Tensar geogrid	Inclined wedges				Sliding between grids		Sliding on grids
		θ_{crit}	R_d	E_d	λ_{GEO-3}	θ_u	λ_{GEO-3}	λ_{GEO-3}
(m)		(°)	(kN/m)	(kN/m)	≤ 1.0	(°)	≤ 1.0	≤ 1.0
6.9	RE520	47.0	12.3	4.0	0.326	4.359	0.339	0.326
6.45	RE520	56.0	21.7	8.2	0.376	4.359	0.37	0.352
6.0	RE520	62.0	34.7	13.1	0.378	4.359	0.397	0.378
5.55	RE520	44.0	71.8	26.4	0.368	4.359	0.421	0.404
5.1	RE520	44.0	88.1	38.8	0.441	4.359	0.445	0.43
4.65	RE520	47.0	104.3	52.9	0.507	4.359	0.468	0.455
4.2	RE520	47.0	120.6	68.6	0.569	4.359	0.49	0.481
3.75	RE520	50.0	136.8	85.8	0.627	4.359	0.511	0.506
3.3	RE520	50.0	153.1	104.8	0.684	4.359	0.533	0.531
2.85	RE520	50.0	169.3	125.0	0.738	4.359	0.554	0.556
2.4	RE520	50.0	185.6	146.5	0.789	4.359	0.574	0.58
1.95	RE560	53.0	201.8	169.8	0.841	4.359	0.595	0.605
1.5	RE560	38.0	177.1	154.0	0.87	4.359	0.615	0.629
1.05	RE560	41.0	208.8	190.3	0.911	4.359	0.635	0.653
0.6	RE560	41.0	223.8	213.4	0.954	4.359	0.656	0.676
0.15	RE560	41.0	238.7	237.8	0.996	4.359	0.674	0.696
0.0	-	41.0	253.6	246.2	0.971	-	-	-
Requirement					≤ 1.0		≤ 1.00	≤ 1.00

For dynamic conditions, vertical acceleration acting downwards:

Level: (m)	Tensar geogrid	Inclined wedges				Sliding between grids		Sliding on grids
		θ_{crit} (°)	R_d (kN/m)	E_d (kN/m)	Λ_{GEO-3} ≤ 1.0	θ_u (°)	Λ_{GEO-3} ≤ 1.0	Λ_{GEO-3} ≤ 1.0
6.9	RE520	29.0	19.0	11.5	0.605	4.359	0.43	0.432
6.45	RE520	50.0	28.4	14.7	0.516	4.359	0.459	0.48
6.0	RE520	59.0	43.7	20.6	0.471	4.359	0.484	0.496
5.55	RE520	62.0	68.2	29.6	0.434	4.359	0.506	0.511
5.1	RE520	68.0	85.5	34.6	0.405	4.359	0.528	0.536
4.65	RE520	44.0	227.6	90.7	0.399	4.359	0.548	0.56
4.2	RE520	47.0	266.8	111.4	0.417	4.359	0.568	0.583
3.75	RE520	47.0	308.3	134.5	0.436	4.359	0.588	0.606
3.3	RE520	50.0	346.4	158.1	0.456	4.359	0.607	0.629
2.85	RE520	29.0	250.4	128.3	0.512	4.359	0.626	0.651
2.4	RE520	29.0	252.8	149.1	0.59	4.359	0.644	0.673
1.95	RE560	20.0	160.3	110.6	0.69	4.359	0.662	0.693
1.5	RE560	29.0	289.2	194.9	0.674	4.359	0.678	0.712
1.05	RE560	32.0	353.8	241.1	0.681	4.359	0.694	0.729
0.6	RE560	32.0	387.3	269.2	0.695	4.359	0.708	0.746
0.15	RE560	32.0	420.7	298.5	0.709	4.359	0.722	0.762
0.0	-	32.0	433.1	308.3	0.712	-	-	-
Requirement					≤ 1.0		≤ 1.00	≤ 1.00

For dynamic conditions, vertical acceleration acting upwards:

Level: (m)	Tensar geogrid	Inclined wedges				Sliding between grids		Sliding on grids
		θ_{crit} (°)	R_d (kN/m)	E_d (kN/m)	Λ_{GEO-3} ≤ 1.0	θ_u (°)	Λ_{GEO-3} ≤ 1.0	Λ_{GEO-3} ≤ 1.0
6.9	RE520	26.0	18.8	13.3	0.706	4.359	0.441	0.446
6.45	RE520	32.0	42.8	23.1	0.54	4.359	0.471	0.475
6.0	RE520	56.0	41.8	19.8	0.474	4.359	0.497	0.502
5.55	RE520	62.0	59.1	25.9	0.439	4.359	0.52	0.528
5.1	RE520	65.0	82.8	33.9	0.409	4.359	0.542	0.553
4.65	RE520	68.0	107.7	41.3	0.384	4.359	0.563	0.578
4.2	RE520	44.0	264.2	102.7	0.389	4.359	0.583	0.602
3.75	RE520	47.0	302.7	122.7	0.405	4.359	0.603	0.625
3.3	RE520	17.0	124.1	58.1	0.469	4.359	0.623	0.648
2.85	RE520	17.0	124.4	70.8	0.57	4.359	0.642	0.671
2.4	RE520	17.0	124.7	84.1	0.675	4.359	0.661	0.693
1.95	RE560	17.0	125.0	98.0	0.784	4.359	0.678	0.713
1.5	RE560	17.0	156.9	112.3	0.716	4.359	0.695	0.731
1.05	RE560	20.0	223.5	153.4	0.686	4.359	0.71	0.749
0.6	RE560	29.0	352.7	242.5	0.687	4.359	0.724	0.766
0.15	RE560	17.0	221.1	160.4	0.726	4.359	0.738	0.783
0.0	-	29.0	393.6	276.1	0.701	-	-	-
Requirement					≤ 1.0		≤ 1.00	≤ 1.00

Notes:

(1) Elevation measured from base of reinforced soil wall.

(2) For wedge checks, Z_d is the resultant of all applied forces and R_d is the resistance provided by the reinforcement.

(3) For sliding on grid, Z_d is the sum of the activating forces and R_d is the sum of the resisting forces.

(4) For sliding between grids, forces are calculated for the steepest plane between the grid at the given elevation and the grid immediately above.

By Pass Timisoara TR2 wall - km 15+060 seismic condition

Tensar
Structural Systems

Steel Mesh Panel
System



IMPORTANT NOTES

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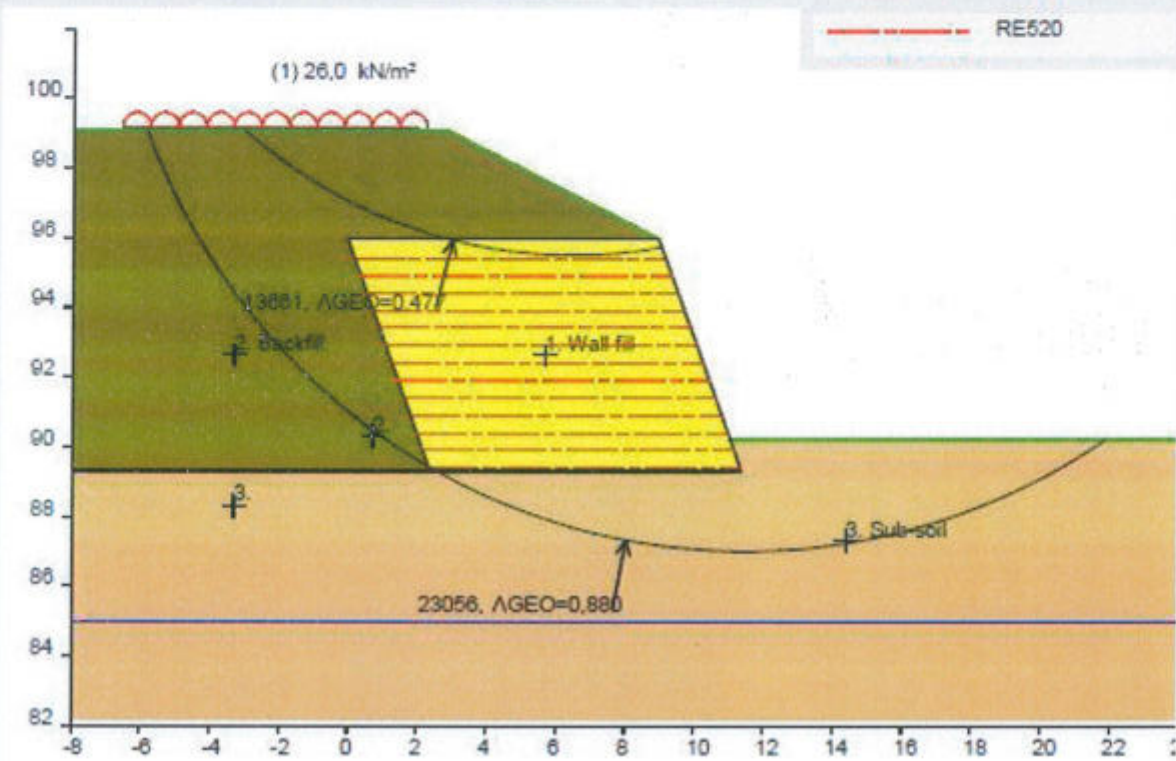
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Method of analysis

The calculation methods used to create this Application Suggestion Application Suggestion is the simplified method of slices using a circular slip surface following the method given by Bishop (Géotechnique, Vol 5, No 1, 1955) modified to take into account the stabilising effect of layers of geogrid reinforcement
Analysis with partial factors defined by EBGE0 2010 (DIN 1054:2010-12) for seismic loading.

Input data and Section

Project: By Pass Timisoara TR2 wall - km 15+060



Tensar Structural Systems Steel Mesh Panel System

Seismic loading case

All dimensions in metres

Scale 1:200

Soil properties

Soil zone	Drained/ undrained	c'_k (kN/m²)	ϕ'_k (°)	$\gamma_{bulk,k}$ (kN/m³)
1. Wall fill	Drained	0,0	33,0 (cv)	18,0
2. Backfill	Drained	35,0	24,0 (cv)	19,6
3. Sub-soil	Drained	5,0	26,0 (cv)	19,0

Soil parameter characteristic values are a cautious estimate of the value affecting the occurrence of the limit state in accordance with Clause 2.4.5.2 (2)P of EN 1997-1:2004, with reference to the National Annex and relevant standards

Surcharges	Load	Load acts from x (m) To x (m)	Load (kN/m²)	Transient/Permanent
1	-6,544	1,956	26,00	Transient

x values are measured from X=0

Loads given above are characteristic values, design values are obtained by applying appropriate partial load factors

Reference O-29345

Date 3 Sep 2019

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Seismic design data g = acceleration due to gravity	Input	External mechanisms	Internal mechanisms		
	$A_h = 0,20g$	$k_h(\text{ext}) = 0,15g$	$k_h(\text{int}) = 0,30g$		
	$A_v = 0,10g$	$k_v(\text{ext}) = 0,05g$	$k_v(\text{int}) = 0,10g$		
	Vertical accelerations may act either downwards or upwards				
	Factor for importance of structure		Y_I	1,20	
	Factor for site topography		S_T	1,0	
	Factor for soil conditions at site		S	1,25	
	Factor for ductility for internal mechanisms		$r(\text{int})$	1,0	
Factor for ductility for external mechanisms		$r(\text{ext})$	2,0		
Note: Where pore water pressures exist, vertical acceleration acts as an undrained loading, producing a change in pore water pressure equal to the change in total stress					
Note: Analysis for the static condition must be carried out in a separate calculation and may be more critical than the seismic case					
Stability results Moments per linear metre of structure	Circle number	Disturbing moment (kNm/m)	Resisting moment soil (kNm/m)	Resisting moment geogrids (kNm/m)	Λ_{GEO}
	23058	28984	32874	75	0,880, Down
	13861	3014	6319	0	0,477, Down
	18365	24417	27785	178	0,873, Down
	19501	24796	27831	531	0,874, Down
	19524	24241	27010	814	0,871, Down
	20844	22480	29145	0	0,771, Down
	21816	26095	29327	584	0,872, Down
	21861	26700	29845	566	0,878, Down
	24186	27724	31145	723	0,870, Down
	24208	29140	32686	602	0,875, Down
	24253	29615	33490	584	0,889, Down
	25405	29743	33311	619	0,877, Down
	Applied partial factors	Soil resistance	Drained frictional resistance $\tan \phi'$	$Y_\phi =$	1,10
			Drained cohesion intercept c'	$Y_c =$	1,10
Undrained shear strength s_u			$Y_{su} =$	1,10	
Overall earth resistance			$Y_{Re} =$	1,0	
Reinforcement		Tensile strength	$Y_M =$	1,20	
		Pullout of reinforcement	$Y_B =$	1,20	
		Sliding on reinforcement	$Y_{GL} =$	1,20	
Loads		Slice weight	$Y_k =$	1,0	
		Permanent applied loads	$Y_G =$	1,0	
		Transient applied loads	$Y_Q =$	1,0	
	Accidental loads (seismic)	$Y_A =$	1,0		

**Further information
relevant to this
Design Analysis**

Further information, specifications and bill of quantities descriptions for this Tensar Earth Retaining Structure are given in the following documents which form part of this Design Analysis

System overview
Installation guide
Case histories

The current versions of these documents may be found by following the website link to "Tensar Documentation" in the Help menu of the TensarSlope program

For program users who do not have a link to the internet contact your nearest Tensar representative or distributor

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Detailed input information

The following tables provide the detailed input information used to define the reinforced fill structure including: coordinates of soil lines and water pressure lines (both internal water pressure and external standing water), geogrid design data and geogrid layout.

In all the tables which follow, X and Y are cartesian coordinates in metres, with Y measured vertically upwards, and measured from X = 0 in the horizontal direction and Y = 0 in the vertical direction.

Soil lines

The soil type found beneath each line is indicated in the table below.

Where a facing is associated with any line, this is also indicated in the table below.

Line No.	X ₁ (m)	Y ₁ (m)	X ₂ (m)	Y ₂ (m)	Soil No.	Facing type
1	40,000	90,210	11,052	90,210	3	
2	11,380	89,310	11,052	90,210	1	Steel mesh panel
3	11,052	90,210	8,956	95,970	1	Steel mesh panel
4	8,956	95,970	2,852	99,080	2	
5	2,852	99,080	-50,000	99,080	2	
6	11,380	89,310	2,380	89,310	3	
7	2,380	89,310	-50,000	89,310	3	
8	2,380	89,310	-0,044	95,970	2	
9	8,956	95,970	-0,044	95,970	1	

Water pressure lines

Pore water pressure at a point is defined according to vertical distance from the following lines:

Line No	X ₁ (m)	Y ₁ (m)	Pressure (kN/m ²)	X ₂ (m)	Y ₂ (m)	Pressure (kN/m ²)
1	-50,000	85,000	0,000	40,000	85,000	0,000

If there is a line above the point examined and none below, then pore pressure is taken to increase hydrostatically with depth below that water pressure line.

If there is a line above the point examined and a line below, then water pressure is interpolated between the pressures on the two lines.

Pressure at a point along a line is determined by linear interpolation

Reinforcement design data

Reinforcement design strength is calculated using the strengths and factors given below

In soil type 1 - Wall fill			Design life (years) seismic		Design temperature (°C) 20	
Tensor Geogrid	Tensile strength (kN/m)	Installation damage factor	Connection factor	Durability factor	Characteristic strength (kN/m)	Sliding coefficient
	R _{B,k0}	A ₂	A ₃	A ₄	R _{B,k}	λ _{GL}
RE520	52,80	1,25	1,00	1,00	42,24	0,85

For the seismic analysis case geogrid design strength is based on the short term tensile strength of the geogrid due to the short duration of loading

Reinforcement layout

Reinforcement level is defined by its Y co-ordinate

Tensar geogrid	Level	Left end	Right end	Length	Coverage	Pullout interaction factor	Fixed at	
	Y (m)	X (m)	X (m)	(m)	(%)	λ_B	left	right
RE520	89,410	2,344	11,344	9,000	100	0,85	No	Yes
RE520	89,910	2,162	11,162	9,000	100	0,85	No	Yes
RE520	90,410	1,980	10,979	8,999	100	0,85	No	Yes
RE520	90,910	1,798	10,797	8,999	100	0,85	No	Yes
RE520	91,410	1,616	10,615	8,999	100	0,85	No	Yes
RE520	91,910	1,434	10,433	8,999	100	0,85	No	Yes
RE520	92,410	1,252	10,251	8,999	100	0,85	No	Yes
RE520	92,910	1,070	10,070	9,000	100	0,85	No	Yes
RE520	93,410	0,888	9,888	9,000	100	0,85	No	Yes
RE520	93,910	0,706	9,706	9,000	100	0,85	No	Yes
RE520	94,410	0,524	9,524	9,000	100	0,85	No	Yes
RE520	94,910	0,342	9,342	9,000	100	0,85	No	Yes
RE520	95,410	0,160	9,160	9,000	100	0,85	No	Yes

By Pass Timisoara TR2 wall - km 15+060 static condition

Tensar
Structural Systems

Steel Mesh Panel
System



IMPORTANT NOTES

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Method of analysis

The calculation methods used to create this Application Suggestion Application Suggestion is the simplified method of slices using a circular slip surface following the method given by Bishop (Géotechnique, Vol 5, No 1, 1955) modified to take into account the stabilising effect of layers of geogrid reinforcement
Analysis with partial factors defined by EBGE0 2010 (DIN 1054:2010-12) for normal loading.

Reference

O-29345

Date

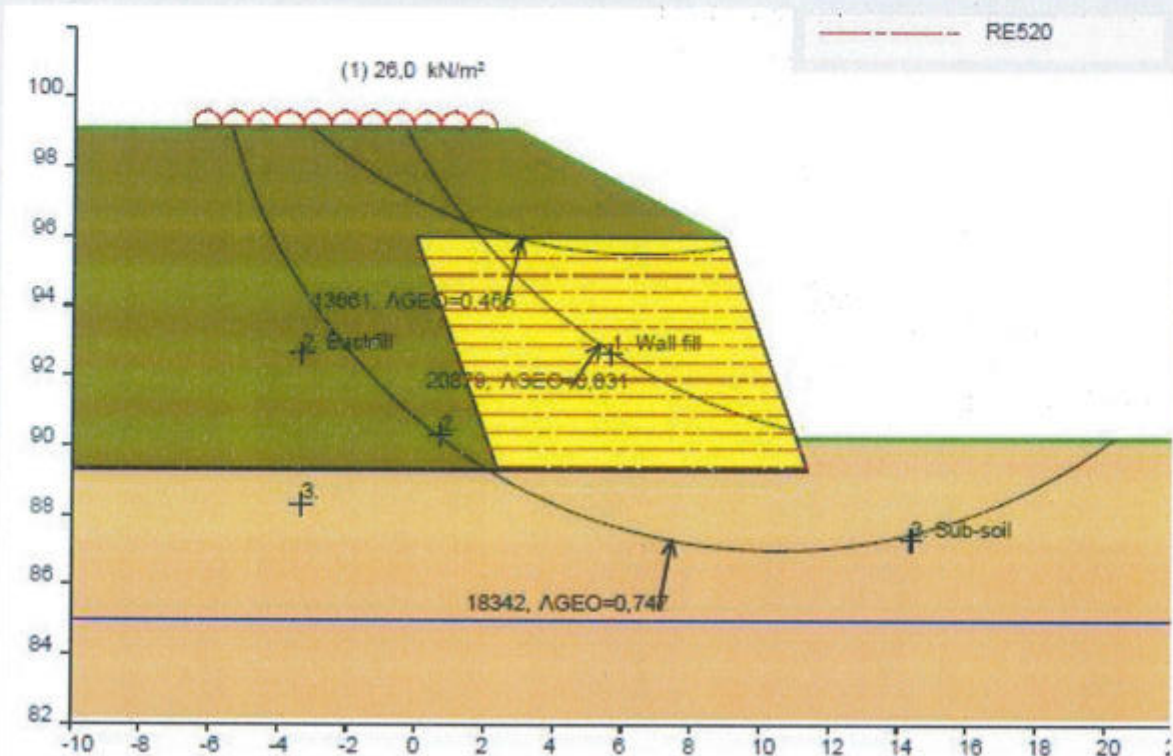
3 Sep 2019

Page

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Input data and Section

Project: By Pass Timisoara TR2 wall - km 15+060



Tensar Structural Systems Steel Mesh Panel System

Normal loading case

All dimensions in metres

Scale 1:200

Soil properties

Soil zone	Drained/ undrained	c'_k (kN/m²)	Φ'_k (°)	$\gamma_{bulk,k}$ (kN/m³)
1, Wall fill	Drained	0,0	33,0 (cv)	18,0
2, Backfill	Drained	35,0	24,0 (cv)	19,6
3, Sub-soil	Drained	5,0	26,0 (cv)	19,0

Soil parameter characteristic values are a cautious estimate of the value affecting the occurrence of the limit state in accordance with Clause 2.4.5.2 (2)P of EN 1997-1:2004, with reference to the National Annex and relevant standards

Surcharges	Load	Load acts from x (m) To x (m)	Load (kN/m²)	Transient/Permanent
1	-6,544	1,956	26,00	Transient

x values are measured from X=0

Loads given above are characteristic values, design values are obtained by applying appropriate partial load factors

Reference O-29345

Date 3 Sep 2019

Page 2 of 5

Stability results Moments per linear metre of structure	Circle number	Disturbing moment (kNm/m)	Resisting moment soil (kNm/m)	Resisting moment geogrids (kNm/m)	Λ_{GEO}
	20879	8411	8066	2057	0,831
	11822	6131	5802	1671	0,820
	12887	6678	6326	1750	0,827
	13661	2687	5777	0	0,465
	18342	18132	24263	0	0,747
	19667	9298	9077	2223	0,823
	19713	7877	7512	1985	0,829
	20833	9851	9737	2302	0,818
	20856	9172	8890	2302	0,820
	22073	8205	7851	2128	0,822
	24465	8896	8298	2460	0,826
	24488	7955	7449	2200	0,824

Applied partial factors As given in DIN 1054:2010-12 and applied to characteristic values to obtain design values	Soil resistance	Drained frictional resistance $\tan \phi'$	$V_{\phi} =$	1,25
		Drained cohesion intercept c'	$V_c =$	1,25
		Undrained shear strength s_u	$V_{su} =$	1,25
		Overall earth resistance	$V_{Re} =$	1,0
	Reinforcement	Tensile strength	$V_M =$	1,40
		Pullout of reinforcement	$V_B =$	1,40
		Sliding on reinforcement	$V_{GL} =$	1,40
	Loads	Slice weight	$V_k =$	1,0
		Permanent applied loads	$V_G =$	1,0
		Transient applied loads	$V_Q =$	1,30
		Accidental loads (seismic)	$V_A =$	1,0

Further information relevant to this Design Analysis	Further information, specifications and bill of quantities descriptions for this Tensar Earth Retaining Structure are given in the following documents which form part of this Design Analysis	System overview Installation guide Case histories
The current versions of these documents may be found by following the website link to "Tensar Documentation" in the Help menu of the TensarSlope program		
For program users who do not have a link to the internet contact your nearest Tensar representative or distributor	Tensar International GmbH +49 (0) 228 / 9 13 92-0 +49 (0) 228 / 9 13 92-11 info@tensar.de Web: www.tensar.co.uk	

Detailed input information

The following tables provide the detailed input information used to define the reinforced fill structure including: coordinates of soil lines and water pressure lines (both internal water pressure and external standing water), geogrid design data and geogrid layout.

In all the tables which follow, X and Y are cartesian coordinates in metres, with Y measured vertically upwards, and measured from X = 0 in the horizontal direction and Y = 0 in the vertical direction.

Soil lines

The soil type found beneath each line is indicated in the table below.

Where a facing is associated with any line, this is also indicated in the table below.

Line No.	X ₁ (m)	Y ₁ (m)	X ₂ (m)	Y ₂ (m)	Soil No.	Facing type
1	40,000	90,210	11,052	90,210	3	
2	11,380	89,310	11,052	90,210	1	Steel mesh panel
3	11,052	90,210	8,956	95,970	1	Steel mesh panel
4	8,956	95,970	2,852	99,080	2	
5	2,852	99,080	-50,000	99,080	2	
6	11,380	89,310	2,380	89,310	3	
7	2,380	89,310	-50,000	89,310	3	
8	2,380	89,310	-0,044	95,970	2	
9	8,956	95,970	-0,044	95,970	1	

Water pressure lines

Pore water pressure at a point is defined according to vertical distance from the following lines:

Line No	X ₁ (m)	Y ₁ (m)	Pressure (kN/m ²)	X ₂ (m)	Y ₂ (m)	Pressure (kN/m ²)
1	-50,000	85,000	0,000	40,000	85,000	0,000

If there is a line above the point examined and none below, then pore pressure is taken to increase hydrostatically with depth below that water pressure line.

If there is a line above the point examined and a line below, then water pressure is interpolated between the pressures on the two lines.

Pressure at a point along a line is determined by linear interpolation

Reinforcement design data

Reinforcement design strength is calculated using the strengths and factors given below

In soil type 1 - Wall fill			Design life (years) 120		Design temperature (°C) 20	
Tensar Geogrid	Creep rupture strength (kN/m)	Installation damage factor	Connection factor	Durability factor	Characteristic strength (kN/m)	Sliding coefficient
	R _{B,k1}	A ₂	A ₃	A ₄	R _{B,k}	λ _{GL}
RE520	25,10	1,25	1,00	1,00	20,08	0,85

Reinforcement layout

Reinforcement level is defined by its Y co-ordinate

Tensar geogrid	Level	Left end	Right end	Length	Coverage	Pullout interaction factor	Fixed at	
	Y (m)	X (m)	X (m)	(m)	(%)	λ _B	left	right
RE520	89,410	2,344	11,344	9,000	100	0,85	No	Yes

Reinforcement continued on next page . . .

Reinforcement layout continued

Tensar geogrid	Level	Left end	Right end	Length	Coverage	Pullout interaction factor	Fixed at	
	Y (m)	X (m)	X (m)	(m)	(%)	λ_B	left	right
RE520	89,910	2,162	11,162	9,000	100	0,85	No	Yes
RE520	90,410	1,980	10,979	8,999	100	0,85	No	Yes
RE520	90,910	1,798	10,797	8,999	100	0,85	No	Yes
RE520	91,410	1,616	10,615	8,999	100	0,85	No	Yes
RE520	91,910	1,434	10,433	8,999	100	0,85	No	Yes
RE520	92,410	1,252	10,251	8,999	100	0,85	No	Yes
RE520	92,910	1,070	10,070	9,000	100	0,85	No	Yes
RE520	93,410	0,888	9,888	9,000	100	0,85	No	Yes
RE520	93,910	0,706	9,706	9,000	100	0,85	No	Yes
RE520	94,410	0,524	9,524	9,000	100	0,85	No	Yes
RE520	94,910	0,342	9,342	9,000	100	0,85	No	Yes
RE520	95,410	0,160	9,160	9,000	100	0,85	No	Yes

Project: Centura Timisoara
km 18+250 H=7.65m

Calcul este realizat pe baza datelor primite de la beneficiar

**Tensar
Structural Systems**

**Custom Modular
Block System**



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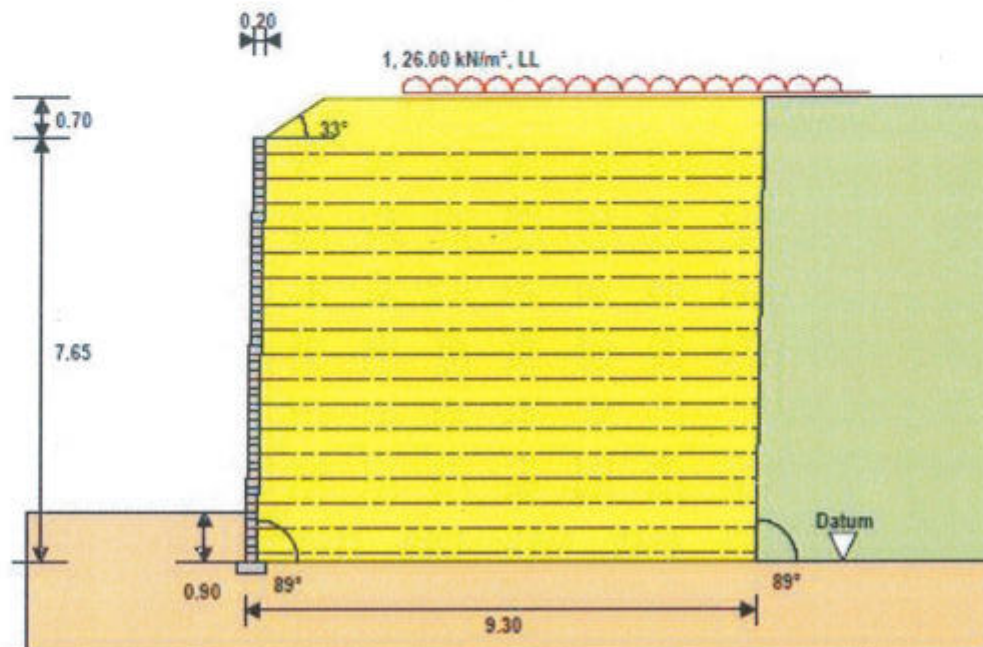
**Method of
analysis**

The calculation method used to create this Tensar Software Output is two-part wedge reinforced soil retaining wall design method with partial factors defined by EBGE0 2010 (DIN 1054:2010-12) for normal BS-P loading and seismic BS-A loading.

Reference km 18+250 H=7.65m

Date 19 Dec 2019

Page 1 of 16



Tensar Structural Systems Custom Modular Block System

Seismic loading case

All dimensions in metres

Scale 1:125

Fill/foundation properties Soil strength parameters are characteristic values	Soil zone	Drained/undrained	c_k (kN/m ²)	ϕ_k (°)	$\gamma_{bulk,k}$ (kN/m ³)
	Reinforced fill	Drained	0.0	33.0 (cv)	18.0
	Retained fill	Drained	0.0	33.0 (cv)	18.0
	Foundation soil	Drained	35.0	36.0 (peak)	19.0

Soil parameter characteristic values are a cautious estimate of the value affecting the occurrence of the limit state in accordance with Clause 2.4.5.2 (2)P of EN 1997-1:2004, with reference to the National Annex and relevant standards

Seismic design data $g =$ acceleration due to gravity	Input	External mechanisms	Internal mechanisms
	$A_h = 0.2g$	$k_E(\text{ext}) = 0.15g$	$k_h(\text{int}) = 0.3g$
	$A_v = 0.1g$	$k_v(\text{ext}) = 0.049g$	$k_v(\text{int}) = 0.099g$
	Vertical accelerations may act either downwards or upwards		
	Factor for importance of structure		$V_I = 1.2$
	Factor for site topography		$S_T = 1.0$
	Factor for soil conditions at site		$S = 1.25$
	Factor for ductility for internal mechanisms		$r(\text{int}) = 1.0$
	Factor for ductility for external mechanisms		$r(\text{ext}) = 2.0$

Surcharges	No	Load acts from x (m)	To x (m)	Load (kN/m ²)	Transient/Permanent
	1	2.49	10.99	26	Transient

x coordinates are measured from the top of the wall.

Unit loads given above are characteristic values, design values are obtained by applying appropriate partial load factors to the resulting actions.

Water pressure data	Location	Height of water level above datum (m)	r_u
	In front of structure	No water pressures	
	Within fill	No water pressures	NA

Verification of external stability	Mechanism	Result	Max/Min	Critical case	OK?
	Eccentricity	$\Lambda_{GLS} = 0.24$	1.0 max	Seismic,	OK
	Sliding on base	0.352	1.0 min	Seismic	OK
	Bearing	0.07	1.0 min	Seismic, max. OT	OK

Verification of internal stability	Mechanism	OK?	Mechanism	OK?
	Wedge check Λ_{GEO-3}	OK	Internal sliding Λ_{GEO-3}	OK

Reinforcement layout Starting and finishing levels are related to datum	Tensar Geogrid	No of layers	Starting level (m)	Vertical spacing (m)	Finishing level (m)	Coverage (%)	λ_B
	RE520	15	1.05	0.45	7.35	100	0.85
	RE560	1	0.60	-	0.60	100	0.85
	RE560	1	0.15	-	-	100	0.85

Reference	km 18+250 H=7.65m	Date	19 Dec 2019	Page	3 of 16
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Partial load factors applied to actions As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values	Limit state for Normal Loading		GEO-2		GEO-3	EQU
	Action	Factor	External	Internal	All	
	Weight of facing	UNF	γ_{face}	1.35	1.0	1.1
		FAV	$\gamma_{\text{face,fav}}$	1.0	1.0	0.9
	Weight of reinforced fill	UNF	γ_{soil}	1.35	1.0	1.1
		FAV	$\gamma_{\text{soil,fav}}$	1.0	1.0	0.9
	DL above reinforced fill	UNF	γ_G	1.35	1.0	1.1
		FAV	$\gamma_{G,\text{fav}}$	1.0	1.0	0.9
	LL above reinforced fill	UNF	γ_Q	1.5	1.3	1.5
		FAV	$\gamma_{Q,\text{fav}}$	0.0	0.0	0.0
	Earth pressure from soil	UNF	γ_{soil}	1.35	1.0	1.1
		FAV	$\gamma_{\text{soil,fav}}$	1.0	1.0	0.9
	Earth pressure from DL	UNF	γ_G	1.35	1.0	1.1
		FAV	$\gamma_{G,\text{fav}}$	1.0	1.0	0.9
	Earth pressure from LL	UNF	γ_Q	1.5	1.3	1.5
		FAV	$\gamma_{Q,\text{fav}}$	1.0	1.0	1.0
	Water pressure	UNF	γ_W	1.0	1.0	1.0
		FAV	$\gamma_{W,\text{fav}}$	1.0	1.0	1.0
	Accidental loads	UNF	γ_A	NA	NA	NA
		FAV	$\gamma_{A,\text{fav}}$	NA	NA	NA

Partial material and resistance factors
As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values

Limit state for Normal Loading			GEO-2	GEO-3	EQU
Material parameter		Factor	External	Internal	All
Friction angle of soil	S1	$\gamma_{\phi 1}$	1.0	1.25	1.0
	S2	$\gamma_{\phi 2}$	1.0	1.25	1.0
	S3	$\gamma_{\phi 3}$	1.0	1.25	1.0
Cohesion intercept of soil	S1	γ_{c1}	1.0	1.25	1.0
	S2	γ_{c2}	1.0	1.25	1.0
	S3	γ_{c3}	1.0	1.25	1.0
Undrained shear strength	S3	γ_{Cu}	1.0	1.25	1.0
Geogrid strength long term		γ_M	NA	1.4	NA
Geogrid strength short term		γ_M	NA	NA	NA
Pullout interaction factor		γ_{Her}	NA	1.4	NA
Sliding interaction factor		γ_{GL1-3}	1.1	1.0	NA
Facing connection strength		γ_B	NA	1.4	NA
Sliding through facing		γ_{face}	NA	1.1	NA
Bearing resistance		γ_{Rv}	1.4	NA	NA
Sliding resistance		γ_{Rh}	1.1	1.0	NA

Partial load factors applied to actions As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values	Limit state for Extreme (Seismic) Loading		GEO-2		GEO-3	EQU
	Action	Factor	External	Internal	All	
	Weight of facing	UNF	Y_{face}	1.1	1.0	1.0
		FAV	$Y_{face,tav}$	1.0	1.0	0.95
	Weight of reinforced fill	UNF	Y_{soil}	1.1	1.0	1.0
		FAV	$Y_{soil,tav}$	1.0	1.0	0.95
	DL above reinforced fill	UNF	Y_G	1.1	1.0	1.0
		FAV	$Y_{G,tav}$	1.0	1.0	0.95
	LL above reinforced fill	UNF	Y_Q	1.1	1.1	1.0
		FAV	$Y_{Q,tav}$	0.0	0.0	0.0
	Earth pressure from soil	UNF	Y_{soil}	1.1	1.0	1.0
		FAV	$Y_{soil,tav}$	1.0	1.0	0.95
	Earth pressure from DL	UNF	Y_G	1.1	1.0	1.0
		FAV	$Y_{G,tav}$	1.0	1.0	0.95
	Earth pressure from LL	UNF	Y_Q	1.1	1.1	1.0
		FAV	$Y_{Q,tav}$	1.0	1.0	1.0
	Water pressure	UNF	Y_W	1.0	1.0	1.0
		FAV	$Y_{W,tav}$	1.0	1.0	1.0
	Accidental loads	UNF	Y_A	1.0	1.0	1.0
		FAV	$Y_{A,tav}$	1.0	1.0	1.0

Partial material and resistance factors As given in DIN 1054:2005-1 and applied to characteristic values to obtain design values	Limit state for Extreme (Seismic) Loading		GEO-2	GEO-3	EQU	
	Material parameter		Factor	External	Internal	All
	Friction angle of soil	S1	$\gamma_{\phi 1}$	1.0	1.1	1.0
		S2	$\gamma_{\phi 2}$	1.0	1.1	1.0
		S3	$\gamma_{\phi 3}$	1.0	1.1	1.0
	Cohesion intercept of soil	S1	γ_{c1}	1.0	1.1	1.0
		S2	γ_{c2}	1.0	1.1	1.0
		S3	γ_{c3}	1.0	1.1	1.0
	Undrained shear strength	S3	γ_{Cu}	1.0	1.0	1.0
	Geogrid strength long term		γ_M	NA	1.0	NA
	Geogrid strength short term		γ_M	NA	1.2	NA
	Pullout interaction factor		γ_{Her}	NA	NA	NA
	Sliding interaction factor		γ_{GL1-3}	1.1	1.0	NA
	Facing connection strength		γ_B	NA	1.2	NA
	Sliding through facing		γ_{Itace}	NA	1.1	NA
Bearing resistance		γ_{Rv}	1.2	NA	NA	
Sliding resistance		γ_{Rh}	1.1	1.0	NA	
Further information relevant to this Tensor Earth Retention System	Further information, specifications and bill of quantities descriptions for this TensorTechEarth Retaining Structure are given in the following documents which form part of this Design Analysis		System overview Installation guide Case histories			
	The current versions of these documents may be found by following the website link to "Tensor Documentation" in the Help menu of the TensorSoft® program					
	For program users who do not have a link to the internet contact your nearest Tensor representative or distributor		Tensor International sro +420 558 711 010 (+420 558 711 010) branna@tensor.cz Web: www.tensor.co.uk			

Detailed calculation results

The following tables provide the detailed results from the design Analysis, including geogrid design data, together with both external and internal analysis results.

External stability - characteristic (unfactored) calculated forces			
Note: negative forces are upwards and to the right			
Loading direction	Units	Vertical	Horizontal
Characteristic static force components			
Forces in or above reinforced block:			
Soil mass	kN/m	1360.479	0.000
Facing	kN/m	32.509	0.000
Dead loads	kN/m	0.000	0.000
Live loads	kN/m	171.992	0.000
From water pressure on base	kN/m	0.000	0.000
From water pressure on face	kN/m	0.000	0.000
Forces behind reinforced block:			
From soil	kN/m	57.569	149.885
From dead loads	kN/m	0.000	0.000
From live loads	kN/m	7.959	20.721
From water pressure	kN/m	0.000	0.000
Additional characteristic static force components due to seismic loading			
Forces in or above reinforced block:			
Soil mass	kN/m	26.611	80.638
Facing	kN/m	1.609	4.876
Dead loads	kN/m	0.000	0.000
Live loads	kN/m	1.452	4.399
From water pressure on base	kN/m	0.000	0.000
From water pressure on face	kN/m	0.000	0.000
Forces behind reinforced block:			
From soil	kN/m	12.782	33.280
From dead loads	kN/m	0.000	0.000
From live loads	kN/m	0.277	0.721
From water pressure	kN/m	0.000	0.000

Verification of external stability - sliding

Partial load and material factors used are as per the GEO limit state.

Sliding resistance is verified for Load combination B.

Loads given below are design values (factored).

Calculation	Units	Static loading	Seismic loading
Design horizontal driving force	kN/m	233.427	299.284
Design horizontal resisting force	kN/m	861.064	850.323
$\Lambda_{\text{GEO-2}}$ (sliding)		0.271	0.352
Requirement		≤ 1.00	≤ 1.00
OK?		OK	OK

Additional sliding check

For inclined structures an additional sliding check is carried out with the back of the reinforced soil block defined by a series of steeper lines until the highest $\Lambda_{\text{GEO-2}}$ value is obtained.

Critical inclination of wall back	deg	90.000	90.000
Design horizontal driving force	kN/m	237.722	302.773
Design horizontal resisting force	kN/m	870.319	859.888
$\Lambda_{\text{GEO-2}}$ (sliding)		0.273	0.352
Requirement		≤ 1.00	≤ 1.00
OK?		OK	OK

Verification of external stability - bearing resistance check

Calculations carried using Meyerhof load distribution to take into account eccentricity.

Characteristic bearing resistance is calculated using unfactored loads.

Partial load and material factors used are as per the GEO limit state.

Bearing resistance is verified for Load combination A, Load combination A (max overturning) and Load combination B.

Static load case:

Calculation	Units	Load case A	LCA max overturning	Load case B
Total vertical load on base (unfactored)	kN/m	1631	1506	1459
Total horizontal load on base (unfactored)	kN/m	171	171	171
Total moment on base (unfactored)	kNm/m	-130	189	126
Factor N_c		50.585	50.585	50.585
Factor N_q		37.752	37.752	37.752
Factor N_b		26.702	26.702	26.702
Factor i_c		0.796	0.780	0.774
Factor i_q		0.802	0.786	0.780
Factor i_y		0.718	0.697	0.689
Effective length L'	m	9.300	9.075	9.127
Characteristic ultimate bearing capacity	kN/m ²	3426	3280	3256
Design bearing resistance	kN/m	31863	29766	29717
Design applied load	kN/m	2228	2041	1459
$\Lambda_{\text{GEO-2}}$ (bearing resistance)		0.070	0.069	0.049
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Seismic load case (vertical acceleration downwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Total vertical load on base (unfactored)	kN/m	1673	1549	1500
Total horizontal load on base (unfactored)	kN/m	295	290	290
Total moment on base (unfactored)	kNm/m	443	708	681
Factor N_c		50.585	50.585	50.585
Factor N_q		37.752	37.752	37.752
Factor N_b		26.702	26.702	26.702
Factor i_c		0.670	0.651	0.641
Factor i_q		0.679	0.660	0.651
Factor i_v		0.559	0.537	0.525
Effective length L^*	m	8.770	8.389	8.419
Characteristic ultimate bearing capacity	kN/m ²	3063	2864	2813
Design bearing resistance	kN/m	28864	24026	23686
Design applied load	kN/m	1836	1699	1500
Λ_{GEO-2} (bearing resistance)		0.068	0.071	0.063
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Seismic load case (vertical acceleration upwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Total vertical load on base (unfactored)	kN/m	1611	1489	1440
Total horizontal load on base (unfactored)	kN/m	287	282	282
Total moment on base (unfactored)	kNm/m	265	531	486
Factor N_c		50.585	50.585	50.585
Factor N_q		37.752	37.752	37.752
Factor N_b		26.702	26.702	26.702
Factor i_c		0.667	0.648	0.637
Factor i_q		0.676	0.657	0.647
Factor i_v		0.556	0.532	0.520
Effective length L^*	m	8.971	8.587	8.625
Characteristic ultimate bearing capacity	kN/m ²	3091	2888	2835
Design bearing resistance	kN/m	27733	24802	24456
Design applied load	kN/m	1774	1640	1440
Λ_{GEO-2} (bearing resistance)		0.064	0.066	0.059
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Verification of external stability - eccentricity

Eccentricity is verified for Load combination A, Load combination A (max overturning), Load combination B (all LSEQU), and serviceability (LSSLS).

Static load case:

Calculation	Units	Load case A	LCA max overturning	Load case B
Partial load factors as per the EQU limit state.				
Design vertical load on base	kN/m	1866	1679	1313
Design moment on base about centreline	kNm/m	-205	243	276
Eccentricity	m	-0.110	0.145	0.210
Maximum permitted	m	3.100	3.100	3.100
Λ_{EQU} (eccentricity)		0.035	0.047	0.068
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK
Partial load factors as per the SLS limit state.				
Design vertical load on base	kN/m	1451	1451	1451
Design moment on base about centreline	kNm/m	26	26	26
Eccentricity	m	0.018	0.018	0.018
Maximum permitted	m	1.550	1.550	1.550
Λ_{SLS} (eccentricity)		0.012	0.012	0.012
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Verification of external stability - eccentricity

Seismic load case (vertical acceleration downwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Partial load factors as per the EQU limit state.				
Design vertical load on base	kN/m	1673	1549	1427
Design moment on base about centreline	kNm/m	443	706	680
Eccentricity	m	0.265	0.456	0.477
Maximum permitted	m	3.100	3.100	3.100
Λ_{EQU} (eccentricity)		0.085	0.147	0.154
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK
Partial load factors as per the SLS limit state.				
Design vertical load on base	kN/m	1492	1492	1492
Design moment on base about centreline	kNm/m	559	559	559
Eccentricity	m	0.374	0.374	0.374
Maximum permitted	m	1.550	1.550	1.550
Λ_{SLS} (eccentricity)		0.242	0.242	0.242
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Verification of external stability - eccentricity

Seismic load case (vertical acceleration upwards):

Calculation	Units	Load case A	LCA max overturning	Load case B
Partial load factors as per the EQU limit state.				
Design vertical load on base	kN/m	1611	1489	1368
Design moment on base about centreline	kNm/m	265	531	505
Eccentricity	m	0.164	0.356	0.369
Maximum permitted	m	3.100	3.100	3.100
λ_{EQU} (eccentricity)		0.053	0.115	0.119
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK
Partial load factors as per the SLS limit state.				
Design vertical load on base	kN/m	1433	1433	1433
Design moment on base about centreline	kNm/m	387	387	387
Eccentricity	m	0.270	0.270	0.270
Maximum permitted	m	1.550	1.550	1.550
λ_{SLS} (eccentricity)		0.174	0.174	0.174
Requirement		≤ 1.00	≤ 1.00	≤ 1.00
OK?		OK	OK	OK

Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below

Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

Design temperature (°C)		10			Design life (years)		120	Limit state	ULS
Tensar geogrid	Creep rupture (kN/m)	Installation damage factor	Connection factor	Durability factor	Tensile resistance factor			Design strength (kN/m)	Sliding coefficient
	$R_{B,k1}$	A_2	A_3	A_4	Y_M			$R_{B,d}$	λ_{GL}
RE520	27.34	1.25	1.0	1.0	1.40			15.62	0.85
RE560	45.93	1.15	1.0	1.0	1.40			28.53	0.85

Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below

Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

Design temperature (°C)		10			Design life (years)		Seismic	Limit state	ULS
Tensar geogrid	Tensile strength	Installation damage factor	Connection factor	Durability factor	Tensile resistance factor			Design strength (kN/m)	Sliding coefficient
	$R_{B,k0}$	A_2	A_3	A_4	Y_M			$R_{B,d}$	λ_{GL}
RE520	57.51	1.25	1.0	1.0	1.20			38.34	0.85
RE560	96.62	1.15	1.0	1.0	1.20			70.01	0.85

Geogrid reinforcement design data

Geogrid design strength is calculated using the strengths and factors given below

Strength values quoted are per metre width of geogrid, and do not take into account percentage coverage

Design temperature (°C)		Design life (years)			Limit state		SLS
Tensar geogrid	Load to limit creep strain (kN/m)	Installation damage factor	Connection factor	Durability factor	Tensile resistance factor	Design strength (kN/m)	Sliding coefficient
	$R_{B,k1}$	A_2	A_3	A_4	γ_M	$R_{s,d}$	λ_{GL}
RE520	11.87	1.0	1.0	1.0	1.00	11.87	0.85
RE560	19.94	1.0	1.0	1.0	1.00	19.94	0.85

Connection strength

T_c for each layer of reinforcement is determined for ULS as follows:

For modular block facings, T_c is determined on the basis of block properties and connection test results as follows:

Modular block parameters				Geogrid parameters				
Block length	L_U	0.400	(m)	Type	T_{uu}	A_{cs}	λ_{cs}	T_{cmax}
Block height	H_U	0.150	(m)		(kN/m)	(kN/m)	(°)	(kN/m)
Block width	W_U	0.205	(m)	RE520	45.020	3.000	26.0	22.510
Weight incl. infill	G_U	26.0	kg	RE560	75.630	5.000	26.0	37.820
Dist to CoG	D_U	0.150	(m)					
Inclination of face	α_U	1.0	°					
Max. grid spacing		0.900	(m)					

Note that a partial factor of 1.4 is applied to the connection strength

Grid coordinates

Levels are measured from the datum and horizontal location is measured from the toe of the wall

Tensar geogrid	Level	Left end	Right end	Length	Coverage	Pullout interaction factor λ_B
	(m)	(m)	(m)	(m)	%	
RE520	7.35	0.13	9.43	9.30	100	0.85
RE520	6.90	0.12	9.42	9.30	100	0.85
RE520	6.45	0.12	9.41	9.30	100	0.85
RE520	6.00	0.11	9.40	9.30	100	0.85
RE520	5.55	0.10	9.40	9.30	100	0.85
RE520	5.10	0.09	9.39	9.30	100	0.85
RE520	4.65	0.08	9.38	9.30	100	0.85
RE520	4.20	0.08	9.37	9.30	100	0.85
RE520	3.75	0.07	9.37	9.30	100	0.85
RE520	3.30	0.06	9.36	9.30	100	0.85
RE520	2.85	0.05	9.35	9.30	100	0.85
RE520	2.40	0.05	9.34	9.30	100	0.85
RE520	1.95	0.04	9.33	9.30	100	0.85
RE520	1.50	0.03	9.33	9.30	100	0.85
RE520	1.05	0.02	9.32	9.30	100	0.85
RE560	0.60	0.01	9.31	9.30	100	0.85
RE560	0.15	0.01	9.30	9.30	100	0.85

Internal stability results

For static conditions:

Level:	Tensar geogrid	Inclined wedges				Sliding between grids		Sliding on grids
		θ_{crit}	R_d	E_d	λ_{GEO-3}	θ_u	λ_{GEO-3}	λ_{GEO-3}
(m)		(°)	(kN/m)	(kN/m)	≤ 1.0	(°)	≤ 1.0	≤ 1.0
6.9	RE520	50.0	11.9	3.7	0.308	2.83	0.213	0.206
6.45	RE520	56.0	21.7	8.0	0.368	2.83	0.234	0.224
6.0	RE520	62.0	34.7	13.0	0.374	2.83	0.252	0.242
5.55	RE520	68.0	48.3	17.6	0.384	2.83	0.269	0.26
5.1	RE520	44.0	88.1	35.1	0.398	2.83	0.285	0.272
4.65	RE520	47.0	104.3	48.5	0.465	2.83	0.296	0.28
4.2	RE520	47.0	120.6	63.8	0.529	2.83	0.304	0.286
3.75	RE520	50.0	136.8	80.4	0.588	2.83	0.309	0.288
3.3	RE520	50.0	153.1	98.9	0.646	2.83	0.312	0.293
2.85	RE520	50.0	169.3	118.7	0.701	2.83	0.317	0.301
2.4	RE520	50.0	185.6	139.7	0.753	2.83	0.324	0.31
1.95	RE520	53.0	201.8	162.5	0.805	2.83	0.332	0.321
1.5	RE520	53.0	218.1	186.8	0.856	2.83	0.341	0.333
1.05	RE520	53.0	233.9	212.3	0.907	2.83	0.351	0.346
0.6	RE560	53.0	249.6	239.1	0.958	2.83	0.361	0.36
0.15	RE560	53.0	278.1	267.2	0.981	2.83	0.372	0.374
0.0	-	56.0	294.1	275.9	0.938	-	-	-
Requirement					≤ 1.0		≤ 1.00	≤ 1.00

For dynamic conditions, vertical acceleration acting downwards:

Level:	Tensar geogrid	Inclined wedges				Sliding between grids		Sliding on grids
		θ_{crit}	R_d	E_d	Λ_{GEO-3}	θ_u	Λ_{GEO-3}	Λ_{GEO-3}
(m)		(°)	(kN/m)	(kN/m)	≤ 1.0	(°)	≤ 1.0	≤ 1.0
6.9	RE520	41.0	14.8	7.4	0.499	2.83	0.279	0.281
6.45	RE520	53.0	26.8	13.0	0.485	2.83	0.298	0.3
6.0	RE520	59.0	44.0	20.0	0.454	2.83	0.314	0.317
5.55	RE520	65.0	61.7	26.3	0.427	2.83	0.328	0.331
5.1	RE520	69.0	85.8	34.3	0.4	2.83	0.34	0.341
4.65	RE520	71.0	110.0	41.5	0.377	2.83	0.348	0.348
4.2	RE520	47.0	268.8	105.1	0.394	2.83	0.354	0.354
3.75	RE520	47.0	308.3	127.8	0.415	2.83	0.36	0.361
3.3	RE520	50.0	348.4	150.9	0.436	2.83	0.366	0.369
2.85	RE520	50.0	387.3	176.8	0.457	2.83	0.372	0.379
2.4	RE520	50.0	428.1	203.8	0.476	2.83	0.38	0.389
1.95	RE520	53.0	464.6	231.0	0.497	2.83	0.389	0.401
1.5	RE520	53.0	504.7	261.3	0.518	2.83	0.398	0.413
1.05	RE520	53.0	543.7	292.6	0.538	2.83	0.408	0.426
0.6	RE560	53.0	582.0	325.0	0.558	2.83	0.418	0.439
0.15	RE560	56.0	621.0	356.7	0.574	2.83	0.429	0.452
0.0	-	56.0	646.0	368.4	0.57	-	-	-
Requirement					≤ 1.0		≤ 1.00	≤ 1.00

For dynamic conditions, vertical acceleration acting upwards:

Level:	Tensar geogrid	Inclined wedges				Sliding between grids		Sliding on grids
		θ_{crit}	R_d	E_d	Λ_{GEO-3}	θ_u	Λ_{GEO-3}	Λ_{GEO-3}
(m)		(°)	(kN/m)	(kN/m)	≤ 1.0	(°)	≤ 1.0	≤ 1.0
6.9	RE520	26.0	18.9	9.9	0.526	2.83	0.283	0.285
6.45	RE520	50.0	25.7	12.4	0.481	2.83	0.302	0.304
6.0	RE520	59.0	38.7	17.6	0.454	2.83	0.318	0.322
5.55	RE520	65.0	53.6	22.9	0.427	2.83	0.332	0.335
5.1	RE520	68.0	73.8	29.7	0.403	2.83	0.343	0.345
4.65	RE520	71.0	94.2	35.9	0.391	2.83	0.352	0.352
4.2	RE520	44.0	264.2	97.1	0.368	2.83	0.358	0.358
3.75	RE520	47.0	302.7	116.5	0.385	2.83	0.363	0.365
3.3	RE520	47.0	343.6	138.5	0.403	2.83	0.369	0.373
2.85	RE520	50.0	381.3	160.2	0.42	2.83	0.376	0.383
2.4	RE520	50.0	421.6	185.2	0.439	2.83	0.384	0.394
1.95	RE520	50.0	461.8	211.2	0.457	2.83	0.393	0.406
1.5	RE520	50.0	502.0	238.3	0.475	2.83	0.402	0.418
1.05	RE520	53.0	538.0	264.9	0.492	2.83	0.412	0.43
0.6	RE560	53.0	577.6	295.0	0.511	2.83	0.422	0.443
0.15	RE560	53.0	618.8	326.1	0.527	2.83	0.432	0.457
0.0	-	53.0	642.6	336.8	0.524	-	-	-
Requirement					≤ 1.0		≤ 1.00	≤ 1.00

Notes:

(1) Elevation measured from base of reinforced soil wall.

(2) For wedge checks, Z_d is the resultant of all applied forces and R_d is the resistance provided by the reinforcement.

(3) For sliding on grid, Z_d is the sum of the activating forces and R_d is the sum of the resisting forces.

(4) For sliding between grids, forces are calculated for the steepest plane between the grid at the given elevation and the grid immediately above.

BREVIAR DE CALCUL

Breviarul de calcul tratează dimensionarea din punct de vedere hidraulic a următoarelor lucrări din cadrul Variantei de ocolire Timișoara Sud:

- dispozitive de scurgere a apelor, respectiv
 - rigole de acostament
 - rigole la partea superioară a structurilor de sprijin
 - șanțuri la piciorul taluzului
 - construcții de epurare a apelor meteorice
 - bazine de retenție
- podețe
- poduri



1. DIMENSIONAREA DISPOZITIVELOR DE SCURGERE A APELOR

Apele de pe platforma drumului sunt colectate în șanțurile sau rigolele de la marginea drumului.

Calculul pentru dimensionarea șanțurilor și rigolelor au fost făcute în funcție de forma acestora, panta longitudinală și coeficienții de rugozitate.

Ecuția folosită este ecuația lui Manning pentru mișcarea permanentă unidimensională în canale cu suprafața liberă uniformă în regim permanent.

$$Q = AC\sqrt{(RI)}$$

unde:

- Q - debitul de calcul;
- n - coeficient de rugozitate;
- A - aria secțiunii de curgere;
- R - raza hidraulică;
- I - panta canalului;
- C - coeficientul lui Chezy.

1.1. Rigolă de acostament

Pentru înălțimi mai mari de 3 m, apele de pe platformă se colectează prin pante transversale în rigolele de acostament amplasate în fața parapetelor marginali care se descarcă prin cascări pe taluz în șanțurile de la piciorul taluzului.

Debitul de calcul pentru dimensionarea rigolei de acostament este cel colectat de pe suprafața carosabilului, de pe lățimea benzilor a acestuia pe lungimea dintre două cascări.

Rigola de acostament va avea aceeași pantă ca și drumul.

În tabelul următor este prezentat calculul debitului capabil al rigolei de acostament pentru diferite pante longitudinale ale acesteia, comparativ cu debitul de ape pluviale colectate de pe carosabil de pe o bandă.

Debitul colectat de pe carosabil a fost calculat pentru diferite distanțe între cascări, și comparat cu debitul capabil al rigolei de acostament.

În funcție de panta drumului, casiiurile se pot amplasa la diferite distanțe între ele.

m1	m2	B (m)	h (m)	n	i	P (m)	A (m ²)	R=A/P	C= (1/n*R ^{1/6})	viteza (m/s)	Qcap (mc/s)	Qcarosabil pentru distanța între casiiuri (mc/s)		
												60m	40m	20m
0.2	4	0.273	0.065	0.015	0.2%	0.334	0.009	0.027	36.367	0.26	0.002	0.008	0.005	0.003
0.2	4	0.273	0.065	0.015	0.3%	0.334	0.009	0.027	36.367	0.32	0.003	0.008	0.005	0.003
0.2	4	0.273	0.065	0.015	0.4%	0.334	0.009	0.027	36.367	0.37	0.003	0.008	0.005	0.003
0.2	4	0.273	0.065	0.015	0.5%	0.334	0.009	0.027	36.367	0.42	0.004	0.008	0.005	0.003
0.2	4	0.273	0.065	0.015	1%	0.334	0.009	0.027	36.367	0.59	0.005	0.008	0.005	0.003
0.2	4	0.273	0.065	0.015	2%	0.334	0.009	0.027	36.367	0.84	0.007	0.008	0.005	0.003
0.2	4	0.273	0.065	0.015	3%	0.334	0.009	0.027	36.367	1.03	0.009	0.008	0.005	0.003
0.2	4	0.273	0.065	0.015	4%	0.334	0.009	0.027	36.367	1.18	0.011	0.008	0.005	0.003

Unde :

m1 – panta șanțului

m2 – panta șanțului

B (m) – lățimea șanțului la bază

H (m) – înălțimea șanțului

i (%) – panta șanțului

P (m) – perimetrul ud

A (m²) – aria de curgere

C – coef. lui Chezy

Rigola de acostament a fost prevăzută și în zone unde sunt prevăzute structuri de sprijin la rambleul drumului și scurgerea apelor de pe carosabil nu se poate face direct pe taluz spre șanțul de picior, astfel:

- km 1+504 – km 1+542 – structură de sprijin din pământ armat pe partea stângă a drumului

Apa preluată de pe ambele benzi ale drumului, de la ultima gură de scurgere de pe pasaj și până după structura de sprijin, se va colecta prin rigola de acostament și va descărca printr-un casiu în șanțul de picior.

pozitie		lungime (m)	m1	m2	B (m)	h (m)	n	i	Qcap (mc/s)	Qcarosabil (mc/s)	raport
1+504	1+542	38	0.2	4	0.315	0.075	0.015	4.00%	0.015	0.013	1.18

- km 5+082 – km 5+310 - structură de sprijin din pământ armat pe ambele părți ale drumului
- km 5+550 – km 5+758 - structură de sprijin din pământ armat pe ambele părți ale drumului
- km 17+840 – km 18+060 - structură de sprijin din pământ armat pe ambele părți ale drumului
- km 18+300 – km 18+540 - structură de sprijin din pământ armat pe ambele părți ale drumului

Pe aceste zone, apa este colectată în rigola de acostament de pe o singură bandă a drumului și descărcată fie prin casiiuri în rigolele de la partea superioară a structurilor de sprijin, fie prin cămine și trecut în partea cealaltă a drumului.

Au fost prevăzute de asemenea rigole de acostament în zonele unde pe una din părțile drumului nu este șanț de picior din cauza existenței canalului de irigații chiar lângă taluzul drumului.

Din rigola de acostament apa va descărca în cămine cu grătar metalic, și din acestea, prin țevă din PVC DN200mm va trece de partea cealaltă a drumului și va descărca în șanțul de la picior.

Apa este colectată în rigola de acostament de pe o singură bandă a drumului pe distanța între două cămine.

Dimensionarea tubului de descărcare

Pentru determinarea diametrului necesar al tubului de descărcare a fost utilizată formula:

$$Q = A \times k \times R^{2/3} \times I^{1/2}$$

A = aria secțiunii de curgere

k = coeficient depinzând de materialul conductei, k = 110

R = raza hidraulică

I = panta radierului tubului, 2 ‰

Diametru (m)	Panta i	Viteza (m/s)	Q capabil tub (l/s)	Q calcul (l/s)	Raport Qcapabil/Qcalcul
0,200	0,02	1,95	56	4	14,4

1.2. Rigolă la partea superioară a structurilor de sprijin

Pe zonele cu structuri de sprijin pe ambele părți ale drumului, din rigolele de acostament apa descarcă prin cascări în rigole amplasate la partea superioară a structurilor de sprijin.

Acestea vor descărca la capătul structurii de sprijin în șanțurile de la piciorul taluzului.

Rigolele prevăzute sunt dreptunghiulare, cu lățimea de 0,3m și înălțimea de 0,25m.

Calculul debitelor aferente rigolelor de la partea superioară a structurilor de sprijin

poziție	lungime	suprafata drum ha	Φ'	suprafata taluz ha	Φ"	Φ mediu ponderat	suprafata totala ha	m	i l/s,ha	Q 10% l/s	Q 10% carosabil si taluz mc/s	Q 2% carosabil si taluz mc/s
5+082	5+310	0.11	0.90	0.04	0.10	0.68	0.16	0.8	220	18.84	0.019	0.040
5+550	5+758	0.10	0.90	0.04	0.10	0.68	0.14	0.8	220	17.19	0.017	0.037
17+840	18+060	0.11	0.90	0.11	0.10	0.50	0.22	0.8	220	19.40	0.019	0.041
18+300	18+540	0.12	0.90	0.02	0.10	0.77	0.14	0.8	220	19.43	0.019	0.041

Verificarea dimensiunilor rigolelor de la partea superioară a structurilor de sprijin

poziție	i	b (m)	B (m)	h (m)	n	P (m)	A (mp)	R=A/P	C= (1/n*R^1/6)	viteza (m/s)	Qcap (mc/s)	Qcalcul (mc/s)	raport Qcap/Qcalcul
5+082	5+310	0.3	0.3	0.2	0.015	0.700	0.06	0.086	44.231	2.24	0.13	0.040	3.35
5+550	5+758	0.3	0.3	0.2	0.015	0.700	0.06	0.086	44.231	2.24	0.13	0.037	3.67
17+840	18+060	0.3	0.3	0.2	0.015	0.700	0.06	0.086	44.231	2.24	0.13	0.041	3.25
18+300	18+540	0.3	0.3	0.2	0.015	0.700	0.06	0.086	44.231	2.24	0.13	0.041	3.24

1.3. Șanțuri la piciorul taluzului

La piciorul taluzelor de rambleu se prevăd șanțuri trapezoidale pereate cu beton.

Șanțurile de la piciorul taluzului vor colecta apele pluviale de pe carosabilul drumului și de pe taluzele acestuia, dirijate prin rigola de acostament prin casuiri.

Calculul hidraulic care stă la baza dimensionării și verificării din punct de vedere hidraulic a șanțurilor la piciorul taluzului sunt efectuate pentru înălțimea maximă a lamei de apă și pentru pantele fundului șanțului conform profilului longitudinal.

Pentru dimensionarea dispozitivelor de scurgere a apelor se compară debitul capabil al acestora cu debitul din precipitații colectat pe sectorul respectiv având condiția de îndeplinit $Q_{cap} > Q_{calcul}$, respectiv raportul să fie supraunitar.

1.3.1 Debite de pe platforma și taluzurile drumului

Determinarea debitelor de ape pluviale s-a efectuat conform SR 1846-2:2007 și STAS 9470-73.

Debitul maxim $Q_{max p\%}$ produs de ploaia de calcul cu probabilitatea de depășire 2% se calculează cu relația:

$$Q_{max p\%} = m \times S \times \Phi \times i_{p\%} \quad (l/s)$$

m = coeficient de reducere a debitului datorat efectului de acumulare a apei meteorice în sistemul de scurgere între momentul începerii ploii și momentul în care se realizează debitul maxim în secțiunea de calcul.

S-a considerat $m = 0,8$ – la timp de ploaie < 40 min.

S = suprafața bazinului de pe care se colectează apa, în ha, respectiv suprafața drumului – din profilele transversale, urmărind panta transversală și lățimea care dă înspre elementul de scurgere

Φ = coeficient de scurgere, adimensional = 0,9 pentru partea carosabilă și 0,1 pentru taluzuri, conform tabel 2, SR 1846-2:2007

$i_{p\%}$ = intensitatea medie a ploii cu probabilitatea de depășire $p\%$, în l/s,ha (cantitatea de apă meteorică ce cade în unitatea de timp pe unitatea de suprafață).

Intensitatea ploii se determină conform STAS 9470-73, din diagramele pe zone, în funcție de durata și frecvența ploii.

Lucrarea se încadrează în zona 13, conform hărții din Fig 1, STAS 9470-73.

Rezultatele calculului, respectiv debitele aferente fiecărui tronson de șanț, atât de pe partea carosabilă, cât și de taluzul rambleului drumului, sunt prezentate în tabelele următoare, pentru fiecare parte a drumului.

Calculul debitelor aferente șanțurilor de pe partea stângă a drumului

descărcare	poziție	lungime	suprafața strada ha	Φ°	suprafața taluz ha	Φ°	Φ mediu ponderat	suprafața totală ha	m	i ‰, ha	Q 10% l/s	Q 10% carosabil și taluz mc/s	Q 2% carosabil și taluz tronsoane mc/s	Q total mc/s
bazin retenție st+dr	0+000	0+000	80	0.04	0.90	0.02	0.10	0.65	0.06	0.8	8.18	0.008	0.017	0.020
bazin retenție st+dr	0+080	0+280	200	0.00	0.90	0.06	0.10	0.10	0.06	0.8	22.5	0.99	0.002	0.002
pasaj peste DJ591 și linii tramvai	0+300	0+640	340	0.00	0.90	0.34	0.10	0.10	0.34	0.8	205	5.63	0.012	0.012
podet (canal deviat)	0+730	0+885	155	0.00	0.90	0.22	0.10	0.10	0.22	0.8	230	4.14	0.004	0.009
podet (canal deviat)	0+885	0+980	95	0.00	0.90	0.06	0.10	0.10	0.06	0.8	240	1.24	0.001	0.003
podet (canal deviat)	1+080	1+230	150	0.00	0.90	0.05	0.10	0.10	0.05	0.8	235	0.96	0.001	0.019
podet (canal)	1+230	1+300	70	0.04	0.90	0.02	0.10	0.63	0.06	0.8	250	7.99	0.008	0.017
podet (canal)	1+313	1+503	190	0.23	0.90	0.19	0.10	0.54	0.42	0.8	230	41.25	0.041	0.088
pasaj CF														
podet (canal deviat)	1+960	1+960	100	0.12	0.90	0.13	0.10	0.49	0.25	0.8	240	23.17	0.023	0.049
podet (canal)	2+380	2+380	420	0.24	0.90	0.16	0.10	0.59	0.40	0.8	200	37.56	0.038	0.080
podet (canal)	2+505	2+505	125	0.08	0.90	0.04	0.10	0.65	0.11	0.8	240	13.63	0.014	0.029
podet (canal deviat)	2+745	2+745	240	0.14	0.90	0.10	0.10	0.58	0.24	0.8	215	23.94	0.024	0.051
podet	2+840	2+840	95	0.06	0.90	0.03	0.10	0.62	0.09	0.8	240	10.43	0.010	0.022
podet (canal deviat)	3+180	3+180	340	0.18	0.90	0.09	0.10	0.64	0.27	0.8	205	27.99	0.028	0.060
pasaj peste conducta și drum tehnologic														
podet (canal)	3+550	3+690	140	0.08	0.90	0.18	0.10	0.36	0.26	0.8	240	17.88	0.018	0.038
podet (canal)	4+073	4+073	383	0.23	0.90	0.27	0.10	0.47	0.50	0.8	200	37.44	0.037	0.116
podet (canal)	4+120	4+120	47	0.03	0.90	0.02	0.10	0.59	0.05	0.8	250	5.43	0.005	0.012
podet (bazin retenție dr)	4+132	4+280	148	0.09	0.90	0.05	0.10	0.62	0.14	0.8	235	15.93	0.016	0.034
podet	4+280	4+580	300	0.18	0.90	0.11	0.10	0.60	0.29	0.8	210	29.03	0.029	0.062
podet	4+580	4+680	300	0.18	0.90	0.10	0.10	0.61	0.28	0.8	210	28.93	0.029	0.062
podet (canal)	4+680	4+955	75	0.05	0.90	0.02	0.10	0.62	0.07	0.8	245	8.41	0.008	0.018
podet	4+955	5+135	180	0.22	0.90	0.05	0.10	0.74	0.27	0.8	225	35.96	0.036	0.077
podet (canal)	5+135	5+180	45	0.03	0.90	0.01	0.10	0.72	0.03	0.8	250	5.01	0.005	0.011
bazin retenție st	5+400	5+400	220	0.18	0.90	0.04	0.10	0.75	0.23	0.8	215	29.33	0.029	0.063
pasaj peste DN59														
bazin retenție st	5+500	5+760	260	0.16	0.90	0.04	0.10	0.75	0.19	0.8	215	24.77	0.025	0.053
podet (canal)	5+910	6+300	390	0.20	0.90	0.10	0.10	0.77	0.21	0.8	235	31.10	0.031	0.066
podet + bazin retenție st	6+327	6+500	173	0.10	0.90	0.04	0.10	0.66	0.15	0.8	200	29.70	0.030	0.063
podet + bazin retenție st	6+500	6+580	80	0.04	0.90	0.03	0.10	0.58	0.07	0.8	250	8.50	0.008	0.018
podet+bazin retenție dr	6+580	6+680	100	0.06	0.90	0.05	0.10	0.56	0.11	0.8	245	11.47	0.011	0.024
podet+bazin retenție dr	6+680	6+840	160	0.08	0.90	0.04	0.10	0.63	0.12	0.8	225	13.68	0.014	0.029
pasaj peste CF														
podet + bazin retenție st	7+410	7+700	290	0.17	0.90	0.31	0.10	0.39	0.49	0.8	210	31.57	0.032	0.067
podet+bazin retenție dr	7+880	8+040	160	0.10	0.90	0.05	0.10	0.62	0.15	0.8	225	18.40	0.018	0.039
podet+bazin retenție dr	8+040	8+280	240	0.13	0.90	0.07	0.10	0.63	0.20	0.8	215	21.96	0.022	0.047
podet+bazin retenție dr	8+280	8+460	180	0.11	0.90	0.05	0.10	0.66	0.15	0.8	225	18.31	0.018	0.039
podet	8+460	8+920	460	0.28	0.90	0.14	0.10	0.63	0.42	0.8	185	38.87	0.039	0.083
podet (canal deviat)	9+320	9+320	400	0.24	0.90	0.13	0.10	0.62	0.37	0.8	200	36.61	0.037	0.078
	9+320	9+760	440	0.26	0.90	0.15	0.10	0.61	0.42	0.8	195	39.47	0.039	0.084
	10+000	10+000	240	0.14	0.90	0.08	0.10	0.61	0.23	0.8	215	23.74	0.024	0.051

podet	10+000	10+579	579	0.37	0.90	0.20	0.10	0.62	0.57	0.8	175	49.53	0.050	0.106	0.388
descarcare in canal dr	10+579	10+767	188	0.11	0.90	0.03	0.10	0.73	0.14	0.8	230	19.23	0.019	0.041	0.041
podet	10+767	10+880	93	0.09	0.90	0.02	0.10	0.77	0.11	0.8	250	16.26	0.016	0.035	0.035
descarcare ?	11+140	11+200	60	0.06	0.90	0.01	0.10	0.76	0.07	0.8	245	10.29	0.010	0.022	0.022
podet	11+400	11+540	140	0.10	0.90	0.15	0.10	0.42	0.25	0.8	240	20.08	0.020	0.043	0.043
descarcare in canal	11+600	11+720	120	0.14	0.90	0.14	0.10	0.50	0.29	0.8	240	27.60	0.028	0.059	0.059
podet (canal)	11+720	12+380	660	0.50	0.90	0.24	0.10	0.64	0.75	0.8	175	66.62	0.067	0.142	0.142
podet + bazin retenitie st	12+380	12+970	590	0.66	0.90	0.21	0.10	0.71	0.87	0.8	175	86.15	0.086	0.184	0.184
podet	12+970	13+620	650	0.76	0.90	0.23	0.10	0.72	0.99	0.8	170	96.18	0.096	0.205	0.205
descarcare in canal	13+620	14+020	400	0.20	0.90	0.10	0.10	0.63	0.30	0.8	200	30.40	0.030	0.065	0.065
podet	14+020	14+280	260	0.16	0.90	0.06	0.10	0.62	0.24	0.8	215	25.58	0.026	0.055	0.055
descarcare in canal	14+280	14+340	60	0.04	0.90	0.02	0.10	0.63	0.05	0.8	250	6.94	0.007	0.015	0.015
podet	14+340	14+400	60	0.04	0.90	0.02	0.10	0.66	0.05	0.8	250	6.79	0.007	0.015	0.015
descarcare in canal	14+400	14+655	255	0.16	0.90	0.06	0.10	0.68	0.21	0.8	215	25.09	0.025	0.054	0.054
podet	14+655	14+920	265	0.16	0.90	0.14	0.10	0.53	0.29	0.8	215	26.94	0.027	0.059	0.120
pasaj peste CF	14+920	15+070	150	0.15	0.90	0.21	0.10	0.43	0.36	0.8	235	29.33	0.029	0.063	0.063
podet	15+270	15+440	170	0.17	0.90	0.24	0.10	0.43	0.41	0.8	225	31.82	0.032	0.068	0.068
descarcare in canal	15+440	15+720	280	0.17	0.90	0.13	0.10	0.54	0.30	0.8	210	27.66	0.028	0.059	0.127
podet	15+720	15+980	140	0.08	0.90	0.04	0.10	0.63	0.13	0.8	240	15.32	0.015	0.033	0.033
bazin retenitie	16+140	16+140	280	0.17	0.90	0.07	0.10	0.66	0.24	0.8	210	26.58	0.027	0.057	0.057
bazin retenitie	16+140	16+240	100	0.05	0.90	0.02	0.10	0.64	0.07	0.8	245	9.29	0.009	0.020	0.020
podet (canal)	16+240	16+740	500	0.36	0.90	0.15	0.10	0.66	0.51	0.8	190	51.53	0.052	0.110	0.110
podet	16+740	17+040	300	0.18	0.90	0.10	0.10	0.62	0.28	0.8	210	28.83	0.029	0.062	0.062
descarcare in canal	17+040	17+520	480	0.29	0.90	0.14	0.10	0.63	0.43	0.8	185	40.49	0.040	0.086	0.086
podet	17+520	17+680	160	0.10	0.90	0.04	0.10	0.65	0.14	0.8	225	16.33	0.016	0.035	0.035
descarcare in canal	17+680	17+830	150	0.17	0.90	0.05	0.10	0.72	0.22	0.8	235	30.37	0.030	0.065	0.065
podet	17+830	17+930	100	0.07	0.90	0.03	0.10	0.67	0.10	0.8	245	12.92	0.013	0.028	0.141
descarcare in canal	17+930	17+970	40	0.03	0.90	0.01	0.10	0.65	0.04	0.8	255	5.40	0.005	0.012	0.152
podet	17+970	18+073	103	0.07	0.90	0.03	0.10	0.68	0.10	0.8	240	12.97	0.013	0.028	0.180
descarcare in canal	18+073	18+180	107	0.06	0.90	0.02	0.10	0.71	0.08	0.8	240	11.48	0.011	0.025	0.025
podet	18+180	18+240	40	0.04	0.90	0.01	0.10	0.78	0.05	0.8	255	7.49	0.007	0.016	0.016
descarcare in canal	18+240	18+540	300	0.18	0.90	0.06	0.10	0.70	0.24	0.8	210	28.22	0.028	0.060	0.154
bazin retenitie	18+540	18+640	100	0.11	0.90	0.02	0.10	0.78	0.13	0.8	245	20.50	0.021	0.044	0.044
podet	18+640	18+700	60	0.06	0.90	0.01	0.10	0.74	0.07	0.8	250	10.33	0.010	0.022	0.022
pod peste canal irigatii	18+700	18+920	220	0.13	0.90	0.08	0.10	0.60	0.21	0.8	215	21.80	0.022	0.047	0.047
podet	18+980	19+200	240	0.14	0.90	0.11	0.10	0.56	0.25	0.8	215	24.11	0.024	0.051	0.051
descarcare in canal	19+200	19+370	170	0.10	0.90	0.06	0.10	0.61	0.16	0.8	225	17.60	0.018	0.038	0.054
podet	19+370	19+390	20	0.01	0.90	0.01	0.10	0.65	0.02	0.8	255	2.31	0.002	0.005	0.017
descarcare in canal	19+390	19+440	50	0.03	0.90	0.02	0.10	0.62	0.05	0.8	245	5.61	0.006	0.012	0.012
subtraversare	19+440	19+600	160	0.10	0.90	0.06	0.10	0.61	0.15	0.8	230	15.93	0.017	0.036	0.036
descarcare in canal	19+600	19+680	80	0.05	0.90	0.03	0.10	0.61	0.08	0.8	240	9.20	0.009	0.020	0.020
subtraversare	19+680	19+800	120	0.07	0.90	0.03	0.10	0.66	0.10	0.8	240	13.04	0.013	0.028	0.028
descarcare in canal	19+800	20+080	280	0.17	0.90	0.07	0.10	0.65	0.24	0.8	210	26.58	0.027	0.057	0.057
podet	20+080	20+140	60	0.04	0.90	0.02	0.10	0.63	0.05	0.8	250	6.84	0.007	0.015	0.015
descarcare in canal	20+140	20+180	40	0.02	0.90	0.01	0.10	0.63	0.04	0.8	255	4.65	0.005	0.010	0.010
podet	20+180	21+160	235	0.14	0.90	0.15	0.10	0.48	0.29	0.8	215	24.45	0.024	0.052	0.052
descarcare in canal	21+160	21+480	160	0.10	0.90	0.06	0.10	0.61	0.15	0.8	230	15.93	0.017	0.036	0.036
podet	21+480	21+565	85	0.05	0.90	0.03	0.10	0.60	0.08	0.8	250	9.79	0.010	0.021	0.021
descarcare in canal	21+565	21+685	130	0.14	0.90	0.04	0.10	0.72	0.18	0.8	240	25.51	0.026	0.054	0.054
podet	21+685	21+900	205	0.23	0.90	0.06	0.10	0.73	0.28	0.8	215	35.93	0.036	0.077	0.077
descarcare in canal	21+900	22+125	225	0.25	0.90	0.08	0.10	0.70	0.33	0.8	215	39.71	0.040	0.085	0.085
podet	22+125	22+564	439	0.48	0.90	0.13	0.10	0.73	0.61	0.8	195	69.85	0.070	0.149	0.149

canal	23+000	22+564	22+760	196	0.20	0.90	0.04	0.10	0.76	0.24	0.8	225	32.53	0.033	0.069	0.069
podet descărcare dr	23+045	23+000	23+045	45	0.05	0.90	0.01	0.10	0.69	0.20	0.8	215	24.31	0.024	0.052	0.121
bazin retenție	23+220	23+045	23+220	175	0.11	0.90	0.05	0.10	0.74	0.06	0.8	245	8.16	0.008	0.017	0.017
podet	23+495	23+220	23+495	275	0.30	0.90	0.09	0.10	0.66	0.16	0.8	225	18.71	0.019	0.040	0.040
podet	23+780	23+495	23+780	285	0.31	0.90	0.09	0.10	0.72	0.39	0.8	210	47.26	0.047	0.101	0.101
descărcare bazin dr	23+940	23+780	23+940	160	0.18	0.90	0.07	0.10	0.68	0.24	0.8	230	30.41	0.030	0.065	0.065
podet	24+340	23+940	24+340	400	0.44	0.90	0.14	0.10	0.70	0.58	0.8	200	65.66	0.066	0.140	0.140
descărcare în canal dr	24+480	24+340	24+480	140	0.08	0.90	0.05	0.10	0.62	0.13	0.8	240	15.40	0.015	0.033	0.033
pod peste canal Bega	24+480	24+720	24+480	240	0.26	0.90	0.18	0.10	0.57	0.45	0.8	215	44.00	0.044	0.094	0.094
podet	25+009	24+890	25+009	119	0.07	0.90	0.12	0.10	0.40	0.19	0.8	240	14.62	0.015	0.031	0.031
podet + bazin retenție st	25+360	25+009	25+120	111	0.13	0.90	0.06	0.10	0.51	0.13	0.8	240	12.74	0.013	0.027	0.027
		25+120	25+360	240	0.12	0.90	0.07	0.10	0.60	0.19	0.8	215	19.81	0.020	0.042	0.042
		25+360	25+520	160	0.17	0.90	0.05	0.10	0.72	0.22	0.8	230	28.70	0.029	0.061	0.061

Verificarea dimensiunilor șanțurilor de pe partea stângă a drumului

descărcare		poziție		i	b (m)	m1	m2	B (m)	h (m)	n	P (m)	A (mp)	R=A/P	C= (1/n·R ^{1/6})	viteza (m/s)	Qcap (mc/s)	Qcalcul (mc/s)	raport Qcap/Qcalcul
bazin retenție st+dr	0+000	0+080	0+80	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.020	22.00
	0+080	0+280	0+80	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.002	203.68
	0+640	0+640	0+640	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.012	35.80
pasaj peste DJ591 și linii tramvai																		
podet (canal deviat)	0+885	0+730	0+885	0.0042	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.76	0.88	0.009	99.93
	0+885	0+980	0.0082	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.47	1.23	0.003	465.53
	1+080	1+230	0.0029	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.47	0.73	0.019	38.35
	1+080	1+300	0.0018	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.017	33.84
podet (canal deviat)	1+230	1+300	0.0018	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.017	33.84
	1+313	1+503	0.0022	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.28	0.64	0.088	7.25
pasaj CF																		
podet (canal deviat)	1+960	1+860	1+960	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.049	8.70
	1+960	2+380	0.0025	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.36	0.68	0.080	8.49
	2+380	2+505	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.029	14.79
	2+505	2+745	0.002	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.22	0.61	0.051	11.91
podet (canal deviat)	2+745	2+840	0.0072	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.31	1.16	0.022	51.86
	2+840	3+180	0.0017	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.12	0.56	0.060	9.39
	3+180	3+180	0.0017	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.12	0.56	0.060	9.39
	3+180	3+510	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.073	5.87
pasaj peste conducta și drum tehnologic																		
podet (canal)	3+550	3+690	0.0011	0.5	0.333	1	1	1.665	0.5	0.015	1.734	0.416625	52.539	0.85	0.36	0.038	9.32	
	3+690	4+073	0.0012	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.94	0.47	0.118	3.99
	4+073	4+120	0.0085	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.65	1.33	0.012	114.39
	4+132	4+280	0.0071	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.29	1.15	0.034	33.73
podet (bazin retenție dr)	4+280	4+580	0.0019	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.19	0.59	0.062	9.57
	4+580	4+880	0.0013	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.98	0.49	0.062	7.95
	4+880	4+955	0.014	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	3.22	1.61	0.018	89.73
	4+955	5+135	0.0033	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.56	0.78	0.133	5.88
podet (canal)	5+135	5+180	0.0075	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.36	1.18	0.011	110.16
	5+180	5+400	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.063	6.88
pasaj peste DN59																		
bazin retenție st	5+400	5+180	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.063	6.88
	5+400	5+760	0.0025	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.36	0.68	0.219	3.11
	5+470	5+910	0.0012	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.94	0.47	0.130	3.63
bazin retenție st	5+760	6+300	0.002	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.22	0.61	0.063	9.60
	5+910	6+300	0.002	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.22	0.61	0.063	9.60

podet (canal)	6+327	6+327	6+500	0.003	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.49	0.75	0.038	19.85
podet + bazin retenție st	6+500	6+500	6+580	0.027	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	4.47	2.24	0.018	123.32
podet+bazin retenție dr	6+580	6+580	6+680	0.0014	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.02	0.51	0.024	20.81
podet+bazin retenție dr	6+680	6+680	6+840	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.029	19.78
pasaj peste CF	6+840	6+840	7+160	0.0012	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.94	0.47	0.073	6.47
podet + bazin retenție st	7+700	7+700	7+880	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.067	6.39
podet+bazin retenție dr	7+880	8+040	8+040	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.039	13.42
podet+bazin retenție dr	8+040	8+280	8+280	0.0011	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.035	16.39
podet+bazin retenție dr	8+280	8+460	8+460	0.0028	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.90	0.45	0.047	9.63
podet (canal deviat)	8+460	8+920	8+920	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.44	0.72	0.039	18.43
podet	8+920	9+320	9+320	0.002	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.083	5.19
podet	9+320	9+760	9+760	0.0013	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.22	0.61	0.078	7.79
podet	9+760	10+000	10+000	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.98	0.49	0.084	5.83
podet	10+000	10+579	10+579	0.0013	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.051	8.50
podet	10+579	10+767	10+767	0.003	0.3	1	1	0.7	0.2	0.015	0.866	0.1	0.116	46.491	0.87	0.09	0.041	2.11
podet	10+767	10+960	10+960	0.0019	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.19	0.59	0.035	17.10
podet	11+140	11+140	11+200	0.0032	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.54	0.77	0.022	35.05
podet	11+200	11+400	11+400	0.0014	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.02	0.51	0.043	11.88
podet	11+400	11+600	11+600	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.059	7.31
podet	11+600	11+720	11+720	0.0015	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.142	3.71
podet	11+720	12+380	12+380	0.0015	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.184	2.87
podet	12+380	12+970	12+970	0.0015	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.065	9.38
podet	12+970	13+620	13+620	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.22	0.61	0.055	15.37
podet	13+620	14+020	14+020	0.002	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.72	1.36	0.015	93.22
podet	14+020	14+280	14+280	0.0038	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.68	0.84	0.055	15.37
podet	14+280	14+340	14+340	0.01	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.72	1.36	0.015	93.22
podet	14+340	14+400	14+400	0.0056	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.04	1.02	0.015	70.25
podet	14+400	14+655	14+655	0.0052	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.96	0.98	0.054	18.33
podet	14+655	14+920	14+920	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.120	3.58
podet	14+920	15+070	15+070	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.063	6.68
podet	15+070	15+440	15+440	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.088	6.34
podet	15+440	15+720	15+720	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.127	3.39
podet	15+720	15+860	15+860	0.0063	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.16	1.08	0.033	33.03
podet	15+860	16+140	16+140	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.057	10.18
podet	16+140	16+240	16+240	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.020	21.70
podet	16+240	16+740	16+740	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.110	3.91
podet	16+740	17+040	17+040	0.0014	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.02	0.51	0.062	8.28
podet	17+040	17+520	17+520	0.0014	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.02	0.51	0.086	5.89
podet	17+520	17+680	17+680	0.0011	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.90	0.45	0.035	12.95
podet	17+680	17+830	17+830	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.065	8.91
podet	17+830	17+930	17+930	0.002	0.5	1	1	1.665	0.5	0.015	1.734	0.416625	0.240	52.539	1.15	0.48	0.141	3.40
podet	17+930	17+970	17+970	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.152	2.82
podet	17+970	18+073	18+073	0.001	0.5	1	1	1.665	0.5	0.015	1.734	0.416625	0.240	52.539	0.81	0.34	0.180	1.88
podet	18+073	18+180	18+180	0.0018	0.5	1	1	1.665	0.5	0.015	1.734	0.416625	0.240	52.539	1.09	0.46	0.025	18.56
podet	18+180	18+240	18+240	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.016	26.92
podet	18+240	18+540	18+540	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.154	2.80
podet	18+540	18+640	18+640	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.044	13.20
podet	18+640	18+700	18+700	0.0012	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.94	0.47	0.022	21.38
podet	18+700	18+920	18+920	0.0013	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.98	0.49	0.047	10.55
podet	18+920	19+200	19+200	0.0016	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.09	0.54	0.051	10.58
podet	19+200	19+370	19+370	0.0041	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.74	0.87	0.054	16.00

	19+370	19+390	0.011	0.5	0.333	1	1.1865	0.5	0.015	1.734	0.416625	0.240	52.539	2.70	1.13	0.017	66.55
	19+390	19+440	0.0011	0.3	1	1	0.9	0.3	0.015	1.149	0.18	0.157	48.921	0.64	0.12	0.012	9.66
subtraversare	19+440	19+600	0.0026	0.3	1	1	0.9	0.3	0.015	1.149	0.18	0.157	48.921	0.64	0.12	0.012	9.66
descărcare dr	19+600	19+680	0.0036	0.3	1	1	0.9	0.3	0.015	1.149	0.18	0.157	48.921	0.64	0.12	0.012	9.66
subtraversare	19+680	19+800	0.001	0.3	1	1	0.9	0.3	0.015	1.149	0.18	0.157	48.921	0.64	0.12	0.012	9.66
descărcare spre parcare	19+800	20+080	0.0025	0.3	1	1	0.9	0.3	0.015	1.149	0.18	0.157	48.921	0.64	0.12	0.012	9.66
subtraversare	20+080	20+140	0.011	0.3	1	1	0.9	0.3	0.015	1.149	0.18	0.157	48.921	0.64	0.12	0.012	9.66
descărcare dr	20+140	20+180	0.042	0.3	1	1	0.9	0.3	0.015	1.149	0.18	0.157	48.921	0.64	0.12	0.012	9.66
podul	21+160	20+925	0.0015	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	21+320	21+480	0.0026	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	21+480	21+565	0.0043	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
descărcare în canal dr	21+565	21+695	0.0055	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	21+695	21+900	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	22+125	21+900	0.0023	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	22+125	22+125	0.0023	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	22+564	22+564	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
canal	23+000	22+564	0.002	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	23+000	22+760	0.002	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	23+045	23+045	0.002	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
bazin reținere	23+220	23+495	0.0027	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	23+495	23+780	0.0011	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	23+780	23+940	0.0021	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
descărcare bazin dr	23+940	24+340	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
podul	24+340	24+480	0.0053	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
descărcare în canal dr	24+480	24+720	0.0012	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.05	0.53	0.052	25.04
pod peste canal Bega																	
podul	25+009	25+009	0.0055	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.02	1.01	0.031	32.34
podul	25+009	25+120	0.012	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.98	1.49	0.027	54.81
podul + bazin reținere st	25+120	25+360	0.0037	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.66	0.83	0.042	19.57
podul	25+360	25+520	0.0028	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.44	0.72	0.061	11.75

Calculul debitelor aferente șanțurilor de pe partea dreaptă a drumului

descărcare	suprafața strada ha	poziție	lungime	suprafața taluz ha	Φ"	Φ mediu ponderat	suprafața totală ha	m	i ‰,ha	Q l/s	Q 10% carosabil si taluz mc/s	Q 2% carosabil si taluz tronsoane mc/s	Q total mc/s
bazin reținere st+dr	0+000	0+80	80	0.05	0.90	0.10	0.07	0.8	250	9.07	0.009	0.019	0.100
bazin reținere st+dr	0+080	0+280	200	0.23	0.90	0.10	0.79	0.26	0.8	225	37.58	0.038	0.080
pasaj peste DJ591 și linia tramvai	0+640	0+640	340	0.43	0.90	0.10	0.55	0.75	0.8	205	68.14	0.068	0.145
podul	0+885	0+885	155	0.19	0.90	0.10	0.47	0.41	0.8	230	34.85	0.035	0.074
(canal deviat)	0+885	0+980	95	0.11	0.90	0.10	0.62	0.17	0.8	240	20.87	0.021	0.045
podul	0+980	1+080	100	0.12	0.90	0.10	0.74	0.15	0.8	240	21.33	0.021	0.046
(canal deviat)	1+080	1+230	150	0.18	0.90	0.10	0.74	0.22	0.8	235	31.27	0.031	0.067
podul (canal)	1+230	1+300	70	0.04	0.90	0.10	0.64	0.06	0.8	250	7.97	0.008	0.017
pasaj CF	1+313	1+525	212	0.00	0.90	0.10	0.10	0.21	0.8	230	3.90	0.004	0.008
podul	1+860	1+960	100	0.00	0.90	0.10	0.10	0.13	0.8	240	2.55	0.003	0.005
(canal deviat)	1+960	2+387	427	0.22	0.90	0.10	0.57	0.37	0.8	200	33.62	0.034	0.072
podul (canal)	2+387	2+540	153	0.09	0.90	0.10	0.62	0.14	0.8	235	16.45	0.016	0.035
podul	2+745	2+745	205	0.12	0.90	0.10	0.59	0.20	0.8	220	20.62	0.021	0.044

podet (canal deviat)	2+745	2+860	115	0.07	0.90	0.04	0.10	0.62	0.11	0.8	240	12.65	0.013	0.027	0.027
podet (canal deviat)	2+860	3+180	320	0.17	0.90	0.08	0.10	0.65	0.25	0.8	210	27.42	0.027	0.059	0.059
pasaj peste conducta si drum tehnologic	3+180	3+510	330	0.20	0.90	0.31	0.10	0.41	0.51	0.8	210	35.20	0.035	0.075	0.075
podet (canal)	3+550	3+670	120	0.07	0.90	0.15	0.10	0.36	0.22	0.8	240	15.32	0.015	0.033	0.033
podet (canal)	3+670	4+073	403	0.24	0.90	0.27	0.10	0.48	0.52	0.8	200	39.20	0.039	0.084	0.116
podet	4+073	4+120	47	0.03	0.90	0.02	0.10	0.60	0.05	0.8	250	5.41	0.005	0.012	0.012
podet	4+132	4+280	148	0.09	0.90	0.05	0.10	0.63	0.13	0.8	235	15.89	0.016	0.034	0.034
podet + bazin retenție dr	4+280	4+580	300	0.18	0.90	0.11	0.10	0.60	0.29	0.8	210	29.03	0.029	0.062	0.062
podet (canal)	4+580	4+890	300	0.18	0.90	0.10	0.10	0.62	0.28	0.8	210	28.86	0.029	0.062	0.062
podet (canal)	4+880	4+955	75	0.05	0.90	0.02	0.10	0.62	0.07	0.8	245	8.41	0.008	0.018	0.018
bazin retenție dr	4+955	5+135	180	0.22	0.90	0.05	0.10	0.74	0.27	0.8	225	35.96	0.036	0.077	0.087
bazin retenție dr	5+135	5+180	45	0.03	0.90	0.01	0.10	0.72	0.03	0.8	250	5.01	0.005	0.011	0.011
pasaj peste DN59	5+180	5+400	220	0.18	0.90	0.04	0.10	0.75	0.23	0.8	215	29.33	0.029	0.063	0.063
bazin retenție dr	5+500	5+760	260	0.16	0.90	0.04	0.10	0.75	0.19	0.8	215	24.77	0.025	0.053	0.191
podet (canal)	5+760	5+910	150	0.18	0.90	0.03	0.10	0.77	0.21	0.8	235	31.10	0.031	0.066	0.138
podet	5+910	6+320	410	0.22	0.90	0.11	0.10	0.64	0.33	0.8	200	33.59	0.034	0.072	0.072
bazin retenție st	6+327	6+500	173	0.10	0.90	0.04	0.10	0.66	0.15	0.8	225	17.59	0.018	0.038	0.038
podet + bazin retenție dr	6+500	6+580	80	0.05	0.90	0.03	0.10	0.58	0.08	0.8	250	9.30	0.009	0.020	0.020
podet + bazin retenție dr	6+580	6+680	100	0.06	0.90	0.04	0.10	0.58	0.10	0.8	245	11.37	0.011	0.024	0.024
podet + bazin retenție dr	6+680	6+840	160	0.10	0.90	0.04	0.10	0.65	0.14	0.8	225	16.33	0.016	0.035	0.035
pasaj peste CF	6+840	7+160	320	0.19	0.90	0.36	0.10	0.38	0.55	0.8	205	34.22	0.034	0.073	0.073
podet	7+410	7+700	290	0.17	0.90	0.31	0.10	0.39	0.49	0.8	210	31.57	0.032	0.067	0.067
podet + bazin retenție dr	7+700	7+880	180	0.11	0.90	0.05	0.10	0.63	0.16	0.8	225	18.47	0.018	0.039	0.039
podet + bazin retenție dr	7+880	8+040	160	0.10	0.90	0.06	0.10	0.61	0.15	0.8	225	16.56	0.017	0.035	0.035
podet + bazin retenție dr	8+040	8+280	240	0.13	0.90	0.07	0.10	0.63	0.20	0.8	215	22.00	0.022	0.047	0.047
podet (canal deviat)	8+280	8+460	180	0.11	0.90	0.05	0.10	0.65	0.16	0.8	225	18.40	0.018	0.039	0.039
podet	8+460	8+920	460	0.28	0.90	0.13	0.10	0.64	0.41	0.8	185	38.74	0.039	0.083	0.083
descarcare in canal	9+320	9+320	400	0.21	0.90	0.12	0.10	0.62	0.33	0.8	200	32.38	0.032	0.069	0.069
descarcare in canal	9+760	10+000	240	0.14	0.90	0.08	0.10	0.61	0.42	0.8	195	39.47	0.039	0.084	0.084
descarcare in canal	10+000	10+700	700	0.42	0.90	0.20	0.10	0.65	0.62	0.8	165	52.48	0.052	0.112	0.112
descarcare in canal	10+700	10+860	160	0.10	0.90	0.03	0.10	0.69	0.13	0.8	225	16.16	0.016	0.034	0.034
descarcare in canal	11+140	10+860	280	0.34	0.90	0.06	0.10	0.77	0.40	0.8	210	51.89	0.052	0.111	0.145
descarcare in canal	11+140	11+380	240	0.13	0.90	0.06	0.10	0.66	0.18	0.8	215	20.64	0.021	0.044	0.044
descarcare in canal	11+840	11+930	90	0.09	0.90	0.02	0.10	0.78	0.10	0.8	250	15.70	0.016	0.034	0.034
descarcare in canal	11+930	11+980	50	0.04	0.90	0.01	0.10	0.72	0.05	0.8	255	6.64	0.007	0.014	0.014
descarcare in canal	12+040	12+280	240	0.19	0.90	0.05	0.10	0.74	0.24	0.8	215	30.55	0.031	0.065	0.065
bazin retenție st	13+600	14+020	420	0.25	0.90	0.12	0.10	0.65	0.37	0.8	200	38.17	0.038	0.081	0.081
descarcare in canal	14+020	14+220	200	0.11	0.90	0.05	0.10	0.64	0.16	0.8	220	17.67	0.018	0.038	0.038
descarcare in canal	14+220	14+340	120	0.06	0.90	0.03	0.10	0.64	0.09	0.8	240	11.57	0.012	0.025	0.025
canal	14+340	14+400	60	0.04	0.90	0.01	0.10	0.68	0.05	0.8	250	6.76	0.007	0.014	0.014
canal	14+580	14+400	180	0.11	0.90	0.04	0.10	0.69	0.15	0.8	225	19.08	0.019	0.041	0.041
pasaj peste CF	14+630	14+920	290	0.17	0.90	0.13	0.10	0.55	0.30	0.8	210	27.19	0.027	0.058	0.058
descarcare in canal	15+440	15+720	280	0.17	0.90	0.13	0.10	0.56	0.29	0.8	210	27.52	0.028	0.059	0.059
descarcare in canal	15+720	15+860	140	0.08	0.90	0.04	0.10	0.65	0.12	0.8	240	15.24	0.015	0.033	0.033
descarcare in canal	15+860	16+140	280	0.15	0.90	0.07	0.10	0.65	0.22	0.8	210	23.99	0.024	0.051	0.051
descarcare in canal	16+140	16+440	300	0.21	0.90	0.06	0.10	0.72	0.27	0.8	210	32.76	0.033	0.070	0.070
descarcare in canal ingași	16+520	16+740	220	0.16	0.90	0.04	0.10	0.73	0.21	0.8	215	25.96	0.026	0.055	0.055
descarcare in canal ingași	16+740	17+120	380	0.20	0.90	0.08	0.10	0.68	0.28	0.8	195	29.46	0.029	0.063	0.063

descărcare în canal irigație	17+520	17+120	17+520	400	0.20	0.90	0.07	0.10	0.69	0.27	0.8	200	29.95	0.030	0.064	0.064	0.038	0.038
		17+520	17+700	180	0.11	0.90	0.03	0.10	0.73	0.14	0.8	225	18.01	0.018	0.038	0.038	0.038	0.038
		17+700	17+810	110	0.13	0.90	0.02	0.10	0.79	0.15	0.8	240	22.43	0.022	0.048	0.048	0.048	0.048
		17+810	17+910	100	0.07	0.90	0.02	0.10	0.74	0.09	0.8	245	12.68	0.013	0.027	0.027	0.123	0.123
podet (canal)	18+073	17+910	17+950	40	0.03	0.90	0.01	0.10	0.70	0.04	0.8	250	5.23	0.005	0.011	0.011	0.135	0.135
		17+950	18+073	123	0.09	0.90	0.03	0.10	0.69	0.12	0.8	240	15.47	0.015	0.033	0.033	0.168	0.168
		18+073	18+160	87	0.06	0.90	0.01	0.10	0.79	0.07	0.8	245	10.93	0.011	0.023	0.023	0.023	0.023
		18+160	18+230	20	0.02	0.90	0.00	0.10	0.78	0.02	0.8	250	3.67	0.004	0.008	0.008	0.240	0.240
canal	18+230	18+230	18+540	310	0.22	0.90	0.06	0.10	0.72	0.28	0.8	210	33.85	0.034	0.072	0.072	0.232	0.232
		18+540	18+680	140	0.16	0.90	0.03	0.10	0.77	0.19	0.8	240	28.17	0.028	0.060	0.060	0.111	0.111
		18+680	18+920	240	0.14	0.90	0.08	0.10	0.62	0.22	0.8	215	23.65	0.024	0.051	0.051	0.051	0.051
pod peste canal irigații																		
podet + bazin retenție dr	19+200	18+960	19+200	240	0.14	0.90	0.11	0.10	0.55	0.25	0.8	215	24.19	0.024	0.052	0.052	0.052	0.052
		19+200	19+440	240	0.14	0.90	0.08	0.10	0.61	0.23	0.8	215	23.74	0.024	0.051	0.051	0.051	0.051
		19+440	19+660	220	0.13	0.90	0.08	0.10	0.61	0.21	0.8	218	22.06	0.022	0.047	0.047	0.103	0.103
bazin retenție dr	19+660	19+660	19+760	100	0.10	0.90	0.03	0.10	0.69	0.13	0.8	220	15.65	0.016	0.033	0.033	0.404	0.404
		19+760	19+800	40	0.02	0.90	0.01	0.10	0.74	0.03	0.8	250	4.44	0.004	0.009	0.009	0.009	0.009
		19+800	19+970	170	0.10	0.90	0.02	0.10	0.75	0.13	0.8	230	17.33	0.017	0.037	0.037	0.037	0.037
		19+970	20+060	90	0.09	0.90	0.02	0.10	0.74	0.11	0.8	240	15.17	0.015	0.032	0.032	0.032	0.032
bazin retenție dr	20+140	20+060	20+140	80	0.05	0.90	0.02	0.10	0.67	0.08	0.8	240	9.82	0.010	0.021	0.021	0.045	0.045
		20+140	20+240	100	0.07	0.90	0.03	0.10	0.64	0.10	0.8	245	12.07	0.012	0.026	0.026	0.026	0.026
bazin retenție dr	20+660	20+240	20+660	420	0.46	0.90	0.16	0.10	0.69	0.62	0.8	200	69.08	0.069	0.147	0.147	0.147	0.147
		20+660	20+860	200	0.22	0.90	0.06	0.10	0.62	0.34	0.8	220	36.96	0.037	0.079	0.079	0.079	0.079
pod peste canal irigații																		
podet	21+177	20+920	21+160	240	0.14	0.90	0.15	0.10	0.49	0.30	0.8	215	24.89	0.025	0.053	0.053	0.053	0.053
		21+165	21+320	135	0.15	0.90	0.06	0.10	0.67	0.21	0.8	240	26.83	0.027	0.057	0.057	0.057	0.057
podet	21+320	21+320	21+480	160	0.10	0.90	0.06	0.10	0.60	0.15	0.8	225	16.59	0.017	0.035	0.035	0.035	0.035
		21+565	21+480	85	0.05	0.90	0.03	0.10	0.60	0.08	0.8	240	9.40	0.009	0.020	0.020	0.020	0.020
canal zona giratie	22+980	22+760	22+980	220	0.14	0.90	0.05	0.10	0.70	0.19	0.8	218	22.94	0.023	0.049	0.049	0.049	0.049
		23+045	23+180	135	0.09	0.90	0.03	0.10	0.69	0.11	0.8	240	15.27	0.015	0.033	0.033	0.033	0.033
podet desc. în canal dr	24+480	24+320	24+480	160	0.10	0.90	0.06	0.10	0.61	0.15	0.8	225	16.56	0.017	0.035	0.035	0.035	0.035
pod peste canal Beșea																		
podet	25+009	24+890	25+009	119	0.07	0.90	0.12	0.10	0.39	0.20	0.8	240	14.74	0.015	0.031	0.031	0.031	0.031
		25+009	25+120	111	0.07	0.90	0.07	0.10	0.50	0.13	0.8	240	12.79	0.013	0.027	0.027	0.027	0.027
podet	25+360	25+120	25+360	240	0.13	0.90	0.07	0.10	0.62	0.20	0.8	215	21.26	0.021	0.045	0.045	0.045	0.045
bazin retenție st	25+360	25+360	25+520	160	0.15	0.90	0.04	0.10	0.72	0.20	0.8	225	25.43	0.025	0.054	0.054	0.054	0.054
		0+000	0+080	80	0.07	0.90	0.02	0.10	0.71	0.09	0.8	240	12.87	0.013	0.027	0.027	0.027	0.027

Verificarea dimensiunilor șanțurilor de pe partea dreaptă a drumului

descărcare	poziție	i	b (m)	m1	m2	B (m)	h (m)	n	P (m)	A (mp)	R=A/P	C= (1/m³R⁴/16)	viteza (m/s)	Qcap (m³/s)	Qcalc (m³/s)	raport Qcap/Qcalc
bazin retenție st-dr	0+000	0+80	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.100	4.32
bazin retenție st-dr	0+640	0+280	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.080	5.37
pasaj peste DJ591 și linia tramvai	0+300	0+640	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.145	2.96
podet	0+730	0+885	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.76	0.88	0.074	11.86
(canal deviat)	0+885	0+980	0.0076	0.5	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.37	1.19	0.045	26.64
podet	0+980	1+080	0.0025	0.5	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.36	0.68	0.046	14.95
(canal deviat)	1+080	1+230	0.0024	0.5	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.33	0.67	0.064	7.96

pasaj CF	podet (canal)	1+313	1+230	1+300	0.0029	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.47	0.73	0.017	43.11
			1+313	1+525	0.0025	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.36	0.68	0.008	81.73
pasaj peste conducta si drum tehnologic	podet (canal deviat)	1+860	1+960	1+960	0.0034	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.59	0.79	0.005	145.60
	podet (canal)	2+387	2+540	2+540	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.072	5.96
	podet (canal)	2+387	2+540	2+540	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.035	12.26
	podet (canal deviat)	2+745	2+745	2+745	0.0011	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.90	0.45	0.044	10.16
	podet	2+745	2+860	2+860	0.0055	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.02	1.01	0.027	37.38
	podet (canal deviat)	3+180	3+180	3+180	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.059	7.35
pasaj peste DN59	podet (canal)	3+550	3+670	3+670	0.001	0.5	1	1	1	1.5	0.5	0.015	1.734	0.416625	0.240	52.539	0.81	0.34	0.033	10.37
	podet (canal)	4+073	4+073	4+073	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.116	3.70
	podet	4+132	4+132	4+280	0.0059	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	3.44	1.72	0.012	148.97
	podet + bazin retenție dr	4+580	4+580	4+580	0.0031	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.09	1.05	0.034	30.83
	podet	4+580	4+580	4+580	0.0013	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.52	0.76	0.062	12.23
	podet (canal)	4+955	4+955	4+955	0.017	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.98	0.49	0.062	7.96
	podet	4+955	5+135	5+135	0.0043	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	3.55	1.78	0.018	98.88
	bazin retenție dr	5+135	5+180	5+180	0.0085	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.51	1.26	0.011	117.27
		5+400	5+400	5+400	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.063	6.88
pasaj peste CF	bazin retenție dr	5+470	5+760	5+910	0.0033	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.56	0.78	0.227	3.44
	podet (canal)	6+327	6+327	6+500	0.0025	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.28	0.64	0.072	8.90
	podet	6+580	6+580	6+580	0.022	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.36	0.68	0.038	18.12
	bazin retenție st	6+580	6+580	6+580	0.011	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	4.04	2.02	0.020	101.74
	podet + bazin retenție dr	6+640	6+640	6+640	0.0014	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.86	1.43	0.024	58.83
pasaj peste CF	podet	7+410	7+700	7+880	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.067	6.39
	podet + bazin retenție dr	8+040	8+040	8+280	0.0021	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.035	12.18
	podet + bazin retenție dr	8+460	8+460	8+460	0.0048	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.25	0.62	0.047	13.28
	podet (canal deviat)	9+320	9+320	9+320	0.0018	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.89	0.94	0.039	24.01
	podet	9+760	9+760	9+760	0.0053	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.98	0.49	0.063	5.93
	descarcare in canal	10+000	10+000	10+700	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.069	8.35
	podet	10+700	10+700	10+700	0.001	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.084	6.85
	descarcare in canal	11+140	11+140	11+140	0.004	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.72	0.86	0.145	5.93
	descarcare in canal	11+140	11+380	11+380	0.0031	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.52	0.76	0.044	17.20
	descarcare in canal	11+840	11+930	11+930	0.001	0.5	1	1	1	1.5	0.5	0.015	1.734	0.416625	0.240	52.539	0.81	0.34	0.034	10.12
	descarcare in canal	12+040	12+280	12+280	0.004	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.014	30.37
	podet	14+020	14+020	14+020	0.0032	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.72	0.86	0.065	13.20
	bazin retenție st	14+220	14+220	14+220	0.087	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	8.03	4.02	0.038	106.44
	podet	14+340	14+340	14+340	0.0025	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.36	0.68	0.025	27.57
	descarcare in canal	14+340	14+400	14+400	0.0027	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.41	0.71	0.014	49.04
	canal	14+580	14+580	14+580	0.0051	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.94	0.97	0.041	23.86
	pasaj peste CF	14+630	14+630	14+630	0.003	0.5	1	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.49	0.75	0.059	12.85

podet descarcare in canal	15+720	15+440	15+720	0.0033	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.56	0.78	0.059	13.31
podet descarcare in canal	16+140	15+860	16+140	0.0029	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.61	0.81	0.033	24.75
descarcare in canal ingaliti	16+740	16+440	16+740	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.47	0.73	0.051	14.31
descarcare in canal ingaliti	17+520	17+120	17+520	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.070	6.16
descarcare in canal ingaliti	17+520	17+120	17+520	0.002	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.055	7.77
descarcare in canal ingaliti	17+520	17+700	17+520	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.22	0.61	0.063	6.84
descarcare in canal ingaliti	17+520	17+810	17+520	0.0015	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.038	11.19
descarcare in canal ingaliti	17+520	17+910	17+520	0.0021	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.00	0.42	0.048	8.68
descarcare in canal ingaliti	17+520	17+950	17+520	0.0081	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.25	0.62	0.123	5.05
descarcare in canal ingaliti	17+520	18+073	17+520	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.60	1.30	0.135	9.64
descarcare in canal ingaliti	17+520	18+160	17+520	0.0098	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.81	0.34	0.168	2.02
descarcare in canal ingaliti	17+520	18+210	17+520	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.70	1.35	0.023	57.75
descarcare in canal ingaliti	17+520	18+230	17+520	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.240	1.79
descarcare in canal ingaliti	17+520	18+540	17+520	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.232	1.85
descarcare in canal ingaliti	17+520	18+680	17+520	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.111	3.89
descarcare in canal ingaliti	17+520	18+920	17+520	0.0014	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.02	0.51	0.051	10.09
pod peste canal ingaliti	19+200	19+200	19+200	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.052	8.34
pod peste canal ingaliti	19+200	19+440	19+200	0.0011	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.90	0.45	0.051	8.91
pod peste canal ingaliti	19+200	19+660	19+200	0.0017	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.12	0.56	0.103	5.46
pod peste canal ingaliti	19+660	19+760	19+660	0.0028	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.39	0.69	0.404	1.72
pod peste canal ingaliti	19+660	19+800	19+660	0.0026	0.3	1	1	0.7	0.2	0.015	0.865	0.1	0.116	46.491	0.81	0.08	0.009	8.50
pod peste canal ingaliti	19+660	19+970	19+660	0.003	0.3	1	1	0.7	0.2	0.015	0.865	0.1	0.116	46.491	0.87	0.09	0.037	2.34
pod peste canal ingaliti	19+660	20+060	19+660	0.0013	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.98	0.49	0.032	15.15
pod peste canal ingaliti	19+660	20+140	19+660	0.0046	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.75	0.73	0.045	16.00
pod peste canal ingaliti	19+660	20+240	19+660	0.0049	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.91	0.95	0.026	36.97
pod peste canal ingaliti	19+660	20+660	19+660	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.147	2.92
pod peste canal ingaliti	19+660	20+880	19+660	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.079	5.46
pod peste canal ingaliti	21+177	20+320	21+177	0.001	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.86	0.43	0.053	8.10
pod peste canal ingaliti	21+177	21+185	21+177	0.0079	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	7.65	3.83	0.057	66.81
pod peste canal ingaliti	21+177	21+320	21+177	0.0068	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	2.25	1.12	0.035	31.70
pod peste canal ingaliti	21+177	21+480	21+177	0.0043	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.79	0.89	0.020	44.48
pod peste canal ingaliti	21+177	21+565	21+177	0.0012	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	0.94	0.47	0.049	9.63
pod peste canal ingaliti	21+177	22+980	21+177	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.033	17.72
pod peste canal ingaliti	21+177	23+045	21+177	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.61	0.81	0.035	22.78
pod peste canal ingaliti	21+177	24+320	21+177	0.0035	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.61	0.81	0.035	22.78
pod peste canal Bega	25+009	24+880	25+009	0.0052	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.96	0.96	0.031	31.20
pod peste canal Bega	25+009	25+120	25+009	0.013	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	3.10	1.55	0.027	56.86
pod peste canal Bega	25+009	25+360	25+009	0.0018	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.16	0.58	0.045	12.73
pod peste canal Bega	25+009	25+520	25+009	0.0027	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.41	0.71	0.062	8.65
pod peste canal Bega	25+009	0+000	25+009	0.0027	0.5	1	1	1.5	0.5	0.015	1.914	0.5	0.261	53.278	1.41	0.71	0.027	25.74

1.4. Conductă de canalizare în zona parcarilor

Pe suprafața celor două parări colectarea apelor pluviale se face prin guri de scurgere și o conductă de canalizare Dn630 mm. Această conductă preia și debitele de pe șanțurile de picior ce ajung în zona parării.

Calculul debitelor

pozitie		suprafata carosabil ha	Φ'	suprafata spatiu verde ha	Φ''	Φ mediu ponderat	suprafata totala ha	m	i l/s,ha	Q 2% carosabil si taluz parcare mc/s	Q total preluat de conducta mc/s
10+580	10+780	0.49	0.9	0.25	0.1	0.63	0.74	0.8	260	0.207	0.248
19+760	19+960	0.49	0.9	0.25	0.1	0.63	0.74	0.8	260	0.207	0.253

Verificarea dimensiunii conductei de canalizare

	Diametru	Panta	Viteza	Qcapabil tub	Qcalcul	raport Qcapabil/Qcalcul
	m		m/s	l/s	l/s	
parcare km 10+670	0.63	0.0025	1.48	418	248.02	1.69
parcare km 19+870	0.63	0.0025	1.48	418	253.43	1.65

1.5. Subtraversări

Acolo unde a fost necesară trecerea apelor din șanțul de picior de pe partea stângă pe partea dreaptă în vederea descărcării, a fost prevăzută subtraversarea cu conducte.

	Diametru	Panta	Viteza	Qcapabil tub	Qcalcul	raport Qcapabil/Qcalcul
	m		m/s	l/s	l/s	
subtraversare km 19+600	0.5	0.0025	1.27	226	55.79	4.05
subtraversare km 19+800	0.5	0.0025	1.27	226	131.07	1.72
subtraversare km 20+140	0.315	0.0025	0.94	66	24.54	2.69

1.6. Construcții de epurare a apelor meteorice

Înainte de deversare apele pluviale sunt trecute prin construcții de epurare, având un sistem de decantare și unul de separare grăsimi.

Separatoarele de hidrocarburi necesare sunt prezentate în tabelul următor:

Nr.	Descărcare	Poziție kilometrică	Parte descărcare	Tip	Capacitate separator
1	bazin retenție ST+DR	0+000	B stg	1	60/180
2			B dr	1	60/180
3	bazin retenție DR	0+640	A stg+dr	5	150/450
4	canal	0+885	A dr	1	60/180
5			B dr	1	60/180
6	canal	1+080	B stg	1	60/180
7			A dr	1	60/180
8			B dr	2	75/225
9	canal	1+313	B stg	2	75/225
10	canal	1+960	A stg	1	60/180
11			B stg	2	75/225

12			B dr	2	75/225
13	canal	2+387	B stg	1	60/180
14			B dr	1	60/180
15	canal	2+745	A stg	4	125/375
16			B stg	1	60/180
17			A dr	3	100/300
18			B dr	1	60/180
19	canal	3+180	A stg	1	60/180
20			B stg	2	75/225
21			A dr	1	60/180
22			B dr	2	75/225
23	canal	4+073	A stg	3	100/300
24			B stg	1	60/180
25			A dr	3	100/300
26			B dr	1	60/180
27	canal	4+132	B stg	1	60/180
28			B dr	1	60/180
29	podet si bazin Dr	4+580	A+B dr	6	225/675
30	podet pe canal	4+955	A stg	1	60/180
31			B stg	4	125/375
32			A dr	1	60/180
33			B dr	4	125/375
34	bazin retentie ST	5+400	A stg	1	60/180
35	bazin retentie DR	5+400	A dr	1	60/180
36	bazin retentie ST	5+470	A stg	1	60/180
37			B stg	6	225/675
38	bazin retentie DR	5+470	A dr	6	225/675
39	podet pe canal	6+327	B stg	1	60/180
40			B dr	1	60/180
41	podet si bazin ST	6+580	A+B stg	2	75/225
42	podet si bazin DR	6+840	A+B dr	6	225/675
43	podet si bazin ST	7+700	A+B stg	6	225/675
44	podet si bazin DR	8+040	A+B stg	5	150/450
45	descarcare in canal - Relocare DE617 (km 8+567) km 0+135 DR	8+460	A+B dr	6	225/675
46	podet pe canal	9+320	A stg	2	75/225
47			B stg	2	75/225
48			A dr	1	60/180
49			B dr	2	75/225
50	podet cu descarcare in canal	10+000	A stg	1	60/180
51			B stg	6	225/675
52			A dr	1	60/180
53			B dr	3	100/300

54	podet cu descarcare in canal DR	11+140	A+B dr	6	225/675
55	pasaj	11+540	A st	1	60/180
56	podet cu descarcare in canal DR	11+720	A+B stg	6	225/675
57	podet pe canal	12+971	A stg	5	150/450
58			B stg	6	225/675
59	podet cu descarcare in canal DR	14+020	A+B stg	6	225/675
60	podet cu descarcare in canal DR	14+340	A+B dr	1	60/180
61	descarcare canal DR	14+580	A dr	1	60/180
62	descarcare canal DR	14+630	B dr	6	225/675
63	podet cu descarcare in canal DR	15+720	A+B dr	6	225/675
64	podet cu descarcare in canal DR	16+140	A+B dr	6	225/675
65	bazin retentie stanga	16+740	A+B stg	5	150/450
66	descarcare canal dr	16+740	A+B dr	3	100/300
67	bazin retentie stanga	17+520	A+B stg	3	100/300
68	descarcare canal dr	17+520	A+B dr	3	100/300
69	podet pe canal	18+073	A stg	5	150/450
70			B stg	1	60/180
71			A dr	5	150/450
72			B dr	1	60/180
73	descarcare canal dr	18+230	A+B dr	6	225/675
74	bazin retentie stanga	18+700	A+B stg	1	60/180
75	podet	19+200	A+B stg	6	225/675
76	bazin retentie dreapta	19+660	A+B dr	6	225/675
77	bazin retentie dreapta	20+140	A+B dr	1	60/180
78	bazin retentie dreapta	20+660	A+B dr	6	225/675
79	podet pe canal	21+177	A stg	1	60/180
80			A dr	1	60/180
81	podet pe canal	21+320	B stg	1	60/180
82			A dr	1	60/180
83			B dr	1	60/180
84	podet cu descarcare in canal DR	21+565	A dr	3	100/300
85	podet cu descarcare in canal DR	21+695	B stg	2	75/225
86	podet cu descarcare in canal DR	22+125	A stg	2	75/225
87	podet cu descarcare in canal DR	22+564	A stg	5	150/450

88	descarcare canal dr	22+980	A dr	1	60/180
89	podet pe canal	23+045	A stg	4	125/375
90			A dr	1	60/180
91			B dr	1	60/180
92	bazin retentie stanga	23+220	A+B stg	5	150/450
93	podet pe canal	23+495	B stg	3	100/300
94	podet si bazin DR	23+940	A+B dr	6	225/675
95	podet cu descarcare in canal DR	24+480	A+B dr	5	150/450
96	podet pe canal	25+009	A stg	1	60/180
97			B stg	1	60/180
98			A dr	1	60/180
99			B dr	1	60/180
100	podet si bazin ST	25+360	A+B stg	6	225/675
	Nod rutier Timisoara la km 11+576				
101	Bretea Dr.1	0+315	A stg	1	60/180
102			B stg	1	60/180
103	Bretea Dr. 2	0+030	A dr	1	60/180
104			B dr	1	60/180
	Nod rutier Timisoara Est km 25+690				
105	Bretea 1-1 Podet tubular f 1000 mm	0+220	B dr	1	60/180
106	Bretea 2-1	0+458	A stg	1	60/180
107	Podet tubular		A dr	1	60/180
108	f 1000 mm		B dr	1	60/180

1.7. Bazine de retenție

Din cauza configurației terenului, precum și a pantelor necesare pentru curgere, nu este peste tot posibilă deșușarea șanțurilor în canalele existente.

De aceea, în punctele de minim ale șanțurilor au fost prevăzute bazine de retenție.

Prin calculul hidraulic se determină volumul util al bazinelor de retenție.

Debitele la care au fost dimensionate bazinele sunt cele colectate de tronsoanele de șanțuri sau rigole până la punctele de minim.

S-a considerat că bazinele trebuie să rețină apa pe perioada cât durează ploaia de calcul, considerată 15 minute.

Pentru fiecare poziție a fost determinat volumul necesar al bazinului, și au fost stabilite dimensiunile în funcție de suprafața disponibilă, astfel încât să se asigure acest volum.

Dimensionarea bazinelor de retenție a fost făcută conform SR 1846-2:2007.

$$V = \frac{1}{2} T_r Q_{\max}$$

unde

Q_{\max} – debitul maxim al ploii de calcul, în mc/s

T_t – durată totală a hidrografului de debit, în secunde

$T_t = 3 t_c$

unde t_c – durată ploii de calcul – 15 min

Nr. crt.	Pozitie kilometrica	Parte	Qmax (mc/s)	Volum necesar bazin (mc)
1	0+000	ax	0.119	160.90
2	0+640	dreapta	0.157	212.00
3	4+580	dreapta	0.247	333.39
4	5+400	stanga	0.063	84.53
5	5+400	dreapta	0.060	81.50
6	5+470	dreapta	0.219	295.65
7	5+470	stanga	0.198	266.71
8	6+580	stanga	0.087	117.10
9	6+840	dreapta	0.209	282.00
10	7+700	stanga	0.214	288.28
11	8+040	dreapta	0.164	222.02
12	16+730	stanga	0.172	231.62
13	17+520	stanga	0.121	163.79
14	18+700	stanga	0.069	92.61
15	19+660	dreapta	0.507	684.07
16	20+140	stanga	0.071	96.22
17	20+660	dreapta	0.226	305.66
18	23+220	stanga	0.131	177.00
19	23+940	dreapta	0.205	276.93
20	25+360	stanga	0.228	308.00
21	0+220	nod DN6 bretea 1-1	0.244	329.40

2. PODEȚE

Dimensionarea podețelor s-a făcut în funcție de rolul lor, respectiv de trecerea a unui curs de apă (canal) sau de descărcare a apelor pluviale din șanțurile de la piciorul taluzului.

La dimensionarea podețelor au fost luate în considerare apele colectate de pe platforma drumului prin șanțuri, conform profilului longitudinal.

Podețele proiectate vor funcționa în regim cu nivel liber de scurgere și din punct de vedere hidraulic trebuie să îndeplinească condițiile următoare:

- trebuie să asigure trecerea debitului de calcul cu menținerea înălțimii libere față de nivelul inferior al suprastructurii;
- nivelul apei în amonte să nu depășească nivelul maxim admis la inundație de obiectivele din amonte;
- viteza apei în podeț și la capătul aval să nu depășească viteza admisă de natura terenului sau de protecția albiei.

2.1. Podețe (toate podețele, mai puțin podeț km 21+177)

Pentru podețele care nu descarcă debite semnificative acumulate pe văi, s-a calculat debitul capabil, în funcție de dimensiuni și de pantă.

S-a comparat debitul capabil al podețului (Q_{cap}) cu debitul de calcul provenit din ploaie (Q_{calc}). În condițiile în care $Q_{cap} > Q_{calc}$ rezultă că podețul este bine dimensionat și poate debușa debitul de calcul.

Tip podeț	b (m)	h (m)	n	i	P (m)	A (mp)	R=A/P	C= (1/n*R ^{1/6})	viteza (m/s)	Qcap (mc/s)
podeț dalat D=5.00m, H=1.96m	5	1.6	0.015	0.2%	8.2	8	0.976	66.392	2.93	23.46
	5	1.6	0.015	0.3%	8.2	8	0.976	66.392	3.59	28.73
	5	1.6	0.015	0.4%	8.2	8	0.976	66.392	4.15	33.18
	5	1.6	0.015	0.5%	8.2	8	0.976	66.392	4.64	37.10
	5	1.6	0.015	1%	8.2	8	0.976	66.392	6.56	52.46
	5	1.6	0.015	2%	8.2	8	0.976	66.392	9.27	74.19
podeț dalat D=3.00m, H=1.96m	3	1.6	0.015	0.2%	6.2	4.8	0.774	63.877	2.51	12.07
	3	1.6	0.015	0.3%	6.2	4.8	0.774	63.877	3.08	14.78
	3	1.6	0.015	0.4%	6.2	4.8	0.774	63.877	3.55	17.06
	3	1.6	0.015	0.5%	6.2	4.8	0.774	63.877	3.97	19.08
	3	1.6	0.015	1%	6.2	4.8	0.774	63.877	5.62	26.98
	3	1.6	0.015	2%	6.2	4.8	0.774	63.877	7.95	38.15
podeț cadru închis D=2.00m, H=2.20m	2	1.9	0.015	0.2%	5.8	3.8	0.655	62.121	2.25	8.55
	2	1.9	0.015	0.3%	5.8	3.8	0.655	62.121	2.75	10.47
	2	1.9	0.015	0.4%	5.8	3.8	0.655	62.121	3.18	12.08
	2	1.9	0.015	0.5%	5.8	3.8	0.655	62.121	3.56	13.51
	2	1.9	0.015	1%	5.8	3.8	0.655	62.121	5.03	19.11
	2	1.9	0.015	2%	5.8	3.8	0.655	62.121	7.11	27.02
podeț cadru închis D=2.00m, H=1.20m	2	0.9	0.015	0.2%	3.8	1.8	0.474	58.846	1.81	3.26
	2	0.9	0.015	0.3%	3.8	1.8	0.474	58.846	2.22	3.99
	2	0.9	0.015	0.4%	3.8	1.8	0.474	58.846	2.56	4.61
	2	0.9	0.015	0.5%	3.8	1.8	0.474	58.846	2.86	5.15
	2	0.9	0.015	1%	3.8	1.8	0.474	58.846	4.05	7.29
	2	0.9	0.015	2%	3.8	1.8	0.474	58.846	5.73	10.31

Debitele colectate de șanțuri care descarcă în podețe se regăsesc în tabelul de la capitolul de calcul al șanțurilor.

Debitele colectate de șanțuri care descarcă într-un podeț sunt mai mici de 2 mc/s, iar debitele canalelor de irigații sunt mai mici de 1 mc/s, mult mai mici decât debitele capabile ale podețelor.

2.2. Podeț peste canal de irigații km 21+177

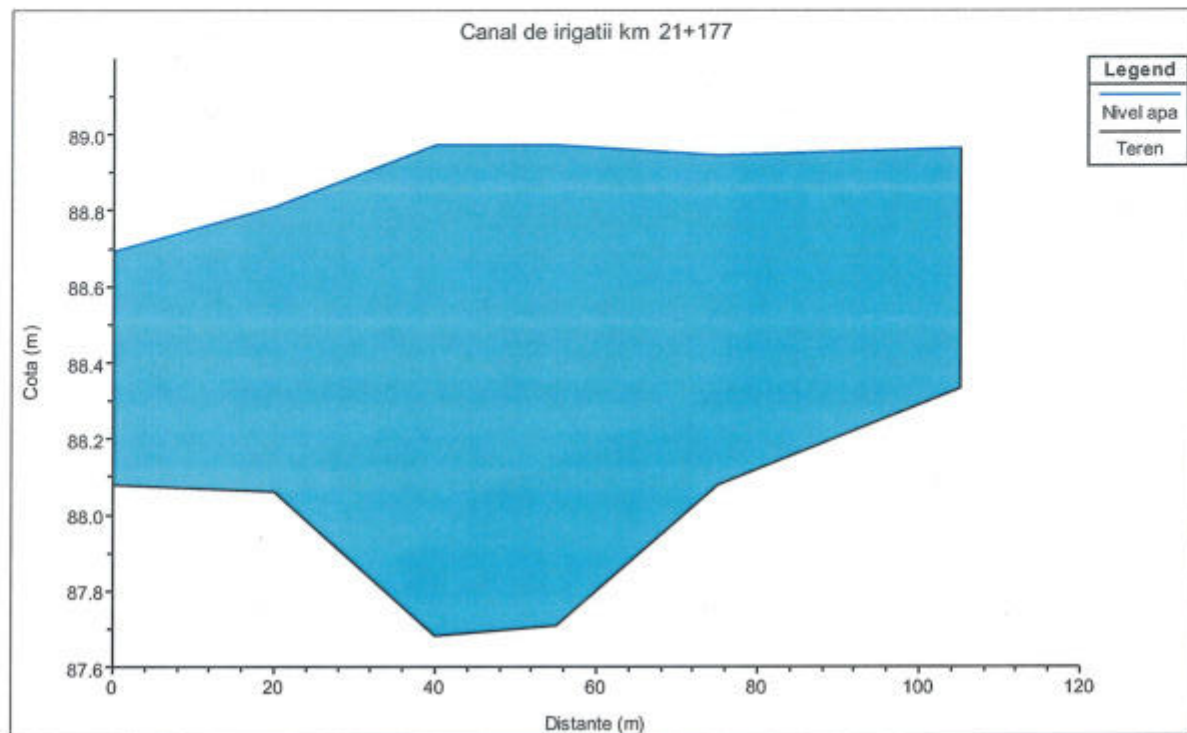
Calculul acestui podeț s-a făcut cu ajutorul modelului matematic HEC-RAS, în regim natural și în regim amenajat cu podeț.

Podețul are deschiderea de 5,00m.

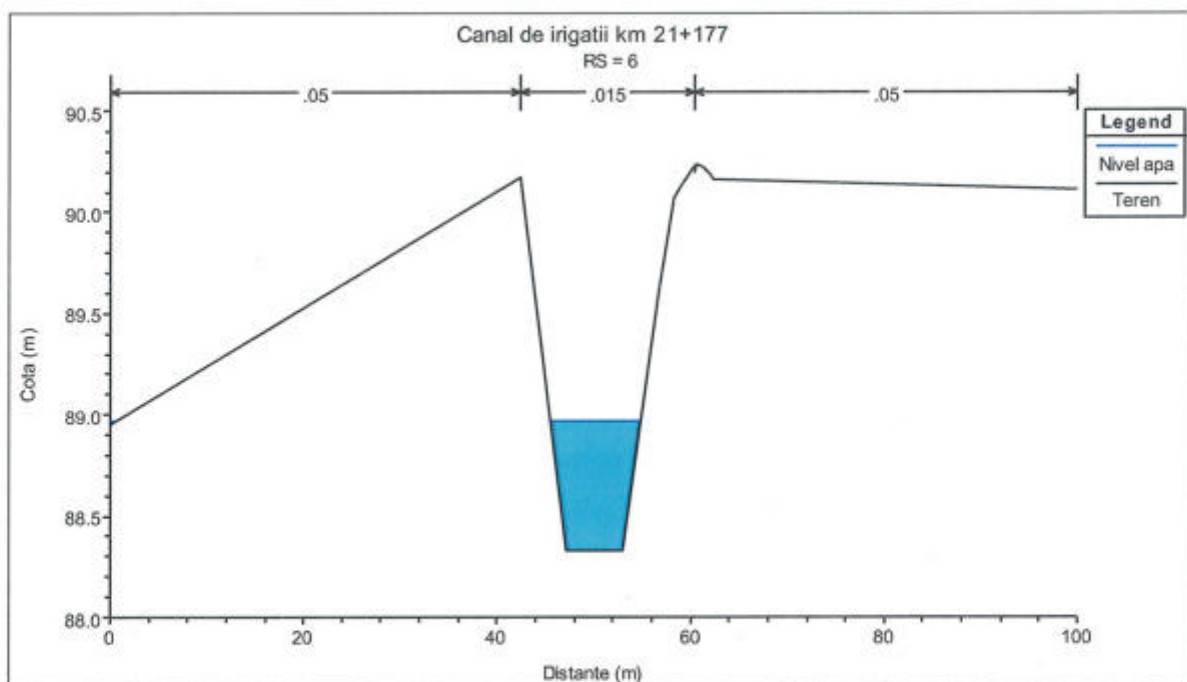
Regim neamenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidrolică (m/m)	Viteza (m/s)	Nr. Froude
6	7.5	88.97	0.001425	1.59	0.71
5	7.5	88.95	0.000896	1.42	0.57
4	7.5	88.97	0.000307	1.04	0.35
3	7.5	88.98	0.000229	0.94	0.30
2	7.5	88.81	0.001819	1.90	0.80
1	7.5	88.69	0.002978	2.22	1.01

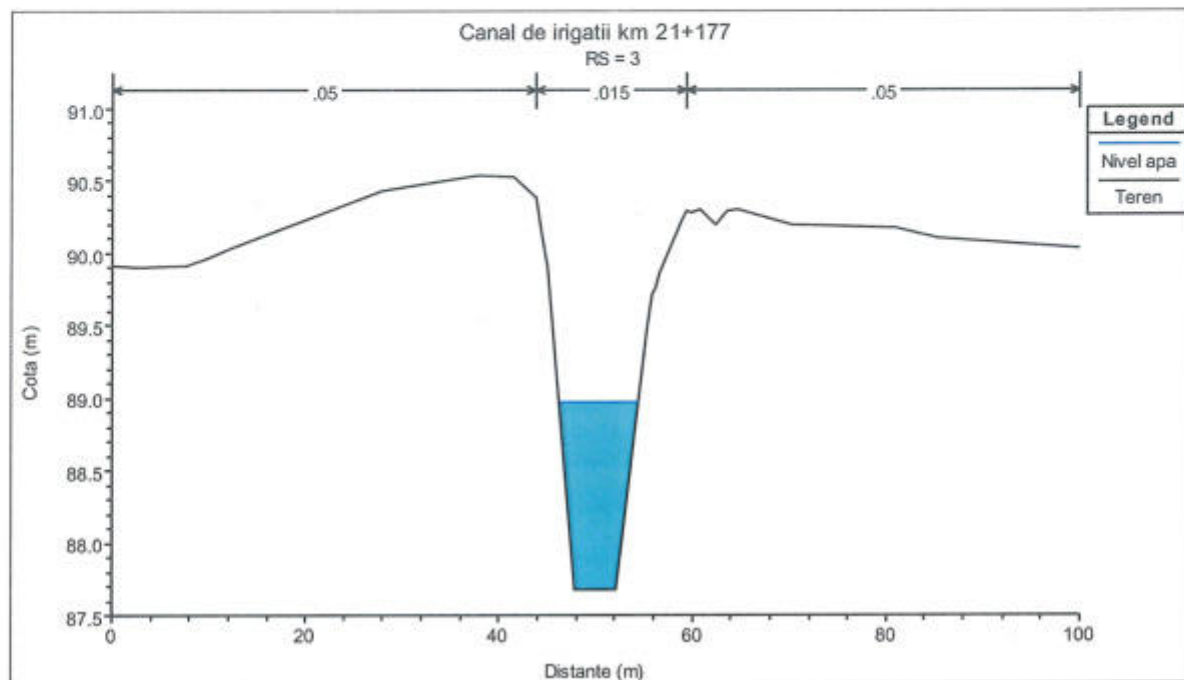
Profil longitudinal



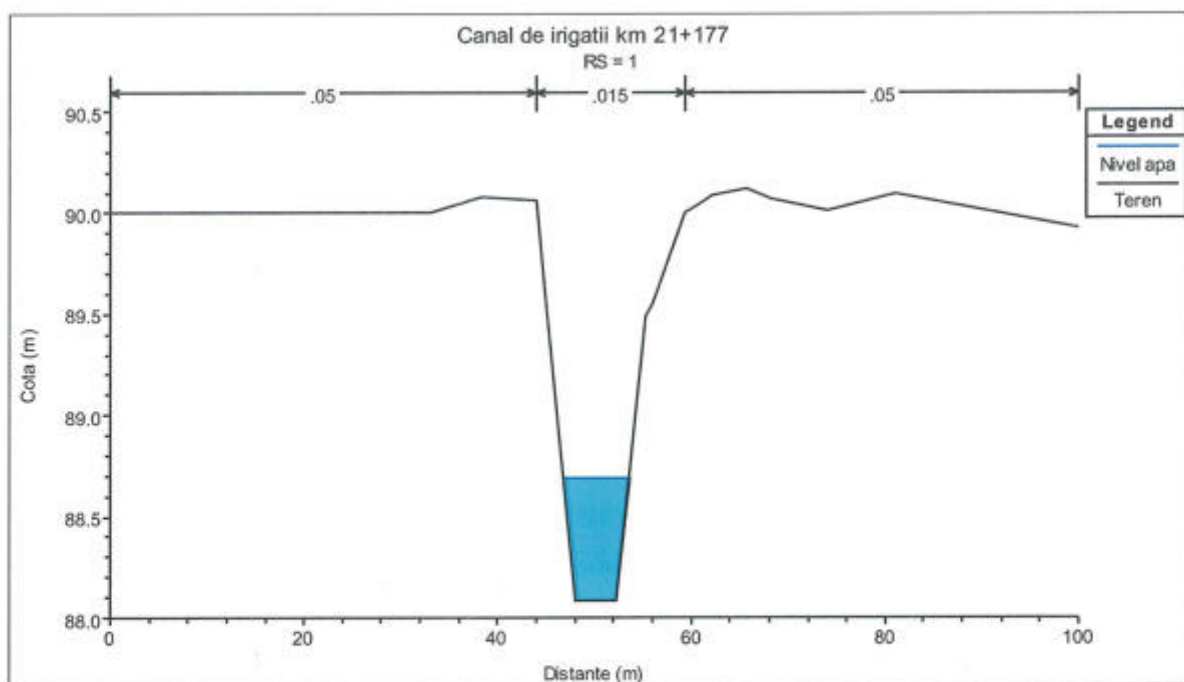
Secțiune transversală amonte de podet



Secțiune transversală în dreptul podețului



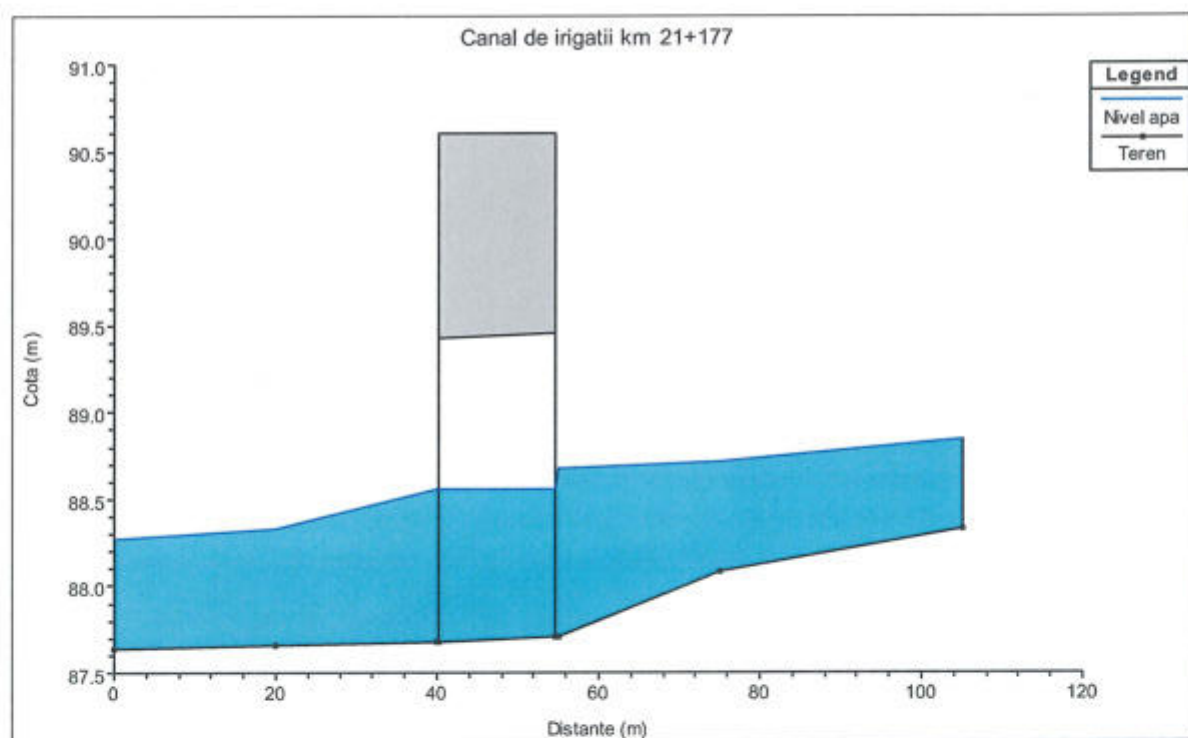
Secțiune transversală aval de podeț



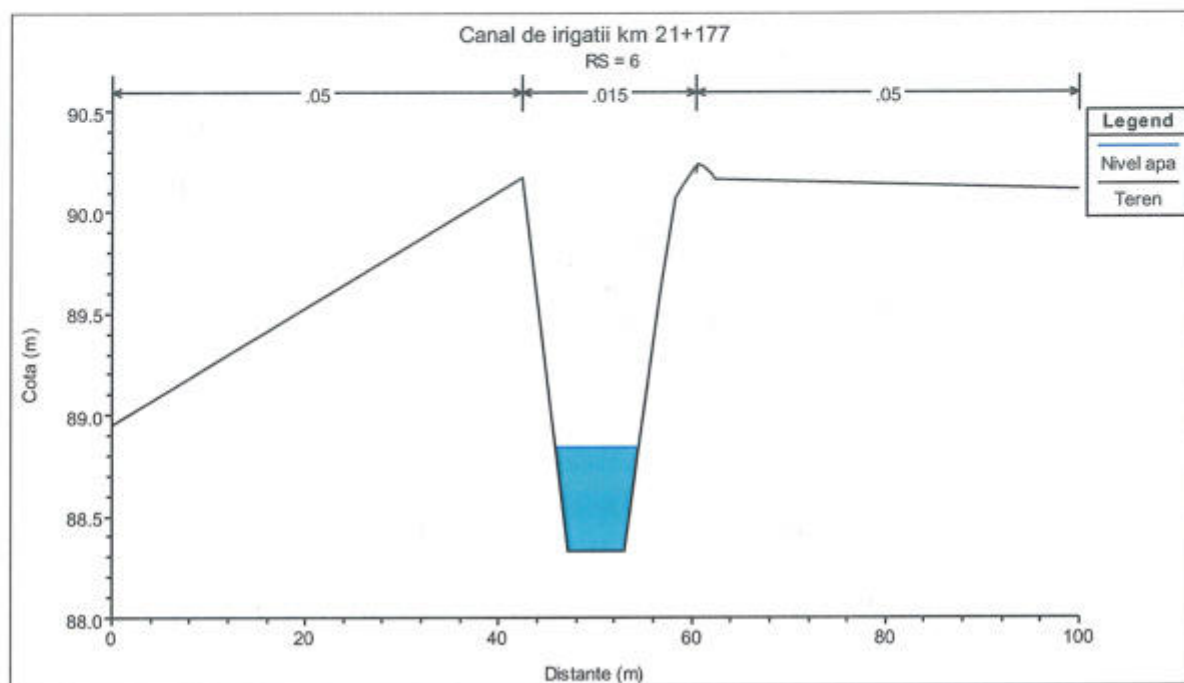
Regim amenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidrolică (m/m)	Viteza (m/s)	Nr. Froude
6	7.5	88.84	0.003034	2.05	1.00
5	7.5	88.72	0.002914	2.17	1.00
4	7.5	88.68	0.000463	1.16	0.42
3.4	Podeț				
3	7.5	88.56	0.000704	1.37	0.51
2	7.5	88.34	0.002974	2.34	1.01
1	7.5	88.27	0.002975	2.28	1.01

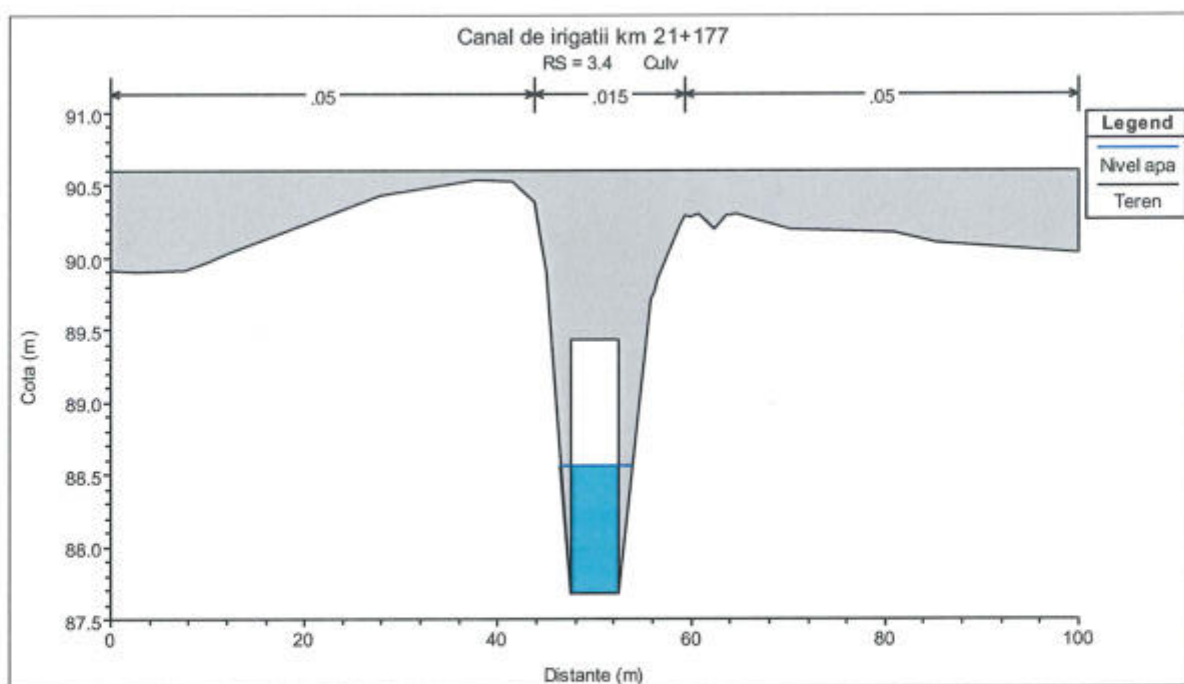
Profil longitudinal



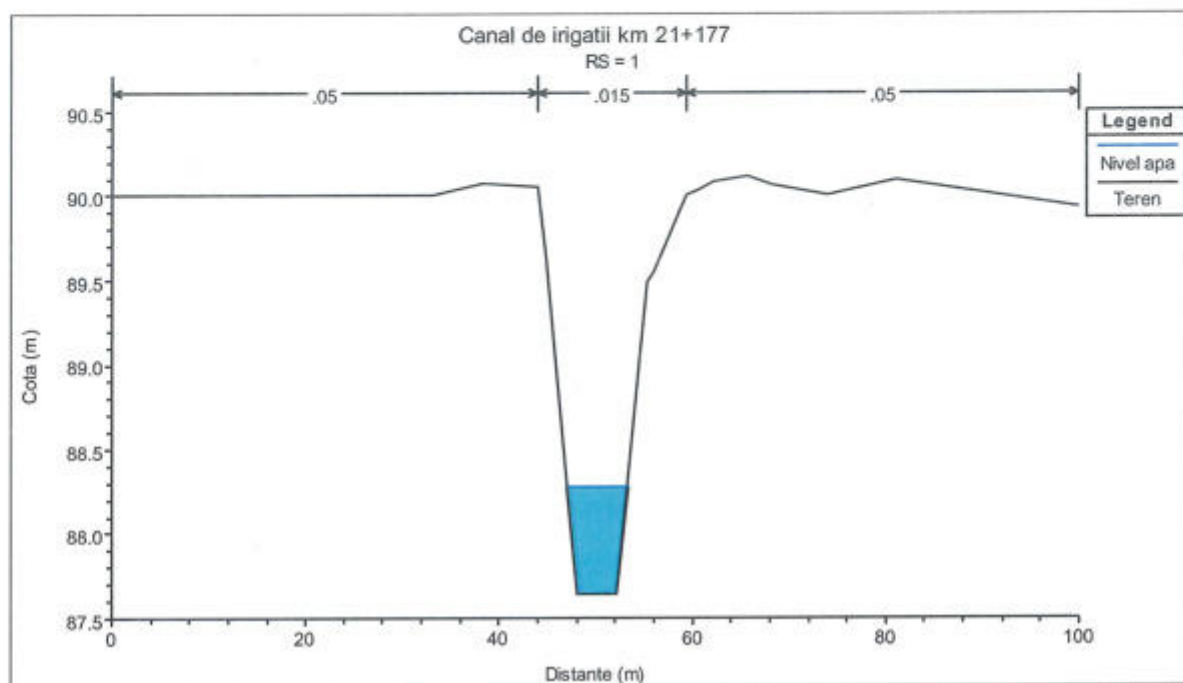
Secțiune transversală amonte de podet



Secțiune transversală în dreptul podețului



Secțiune transversală aval de podet



3. PODURI

Pentru realizarea calculelor hidraulice s-a folosit modelul matematic HEC-RAS privind mișcarea în regim permanent pentru determinarea nivelurilor corespunzătoare debitelor de calcul.

Calculule hidraulice s-au efectuat în regim neamenajat și în regim amenajat respectiv cu sau fără amplasarea podului.

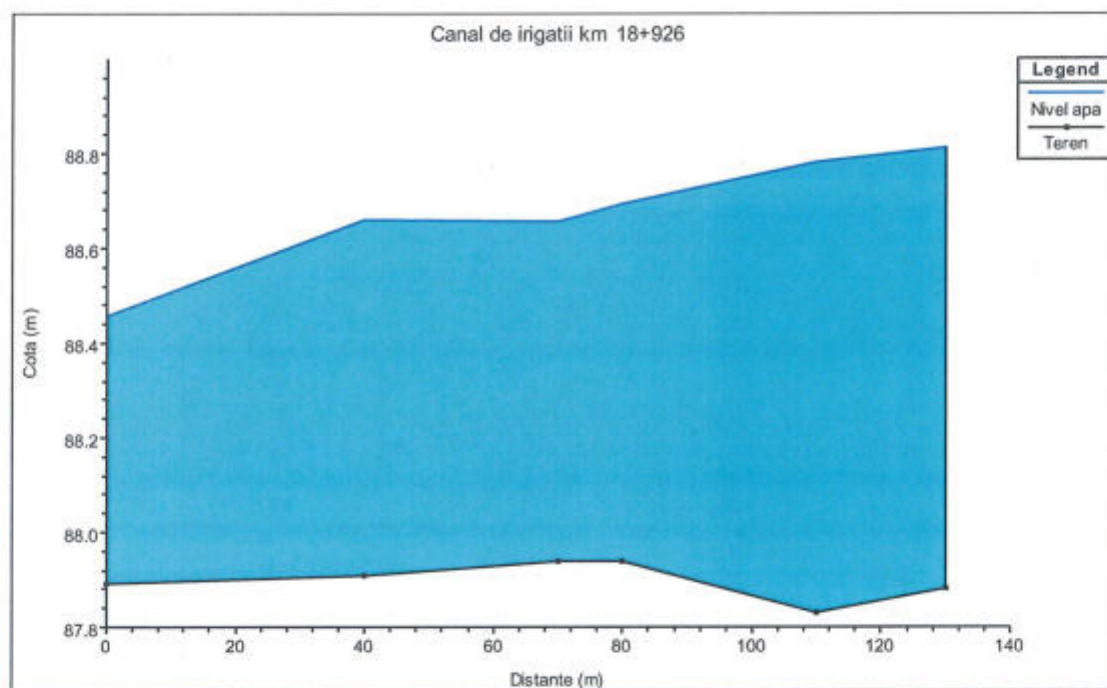
3.1. Pod peste canal de irigații km 18+926

Podul face un unghi de 63 de grade față de cursul de apă și are o singură deschidere de 25,50 m. Cota minimă a intradosului este 90,67 mdMN.

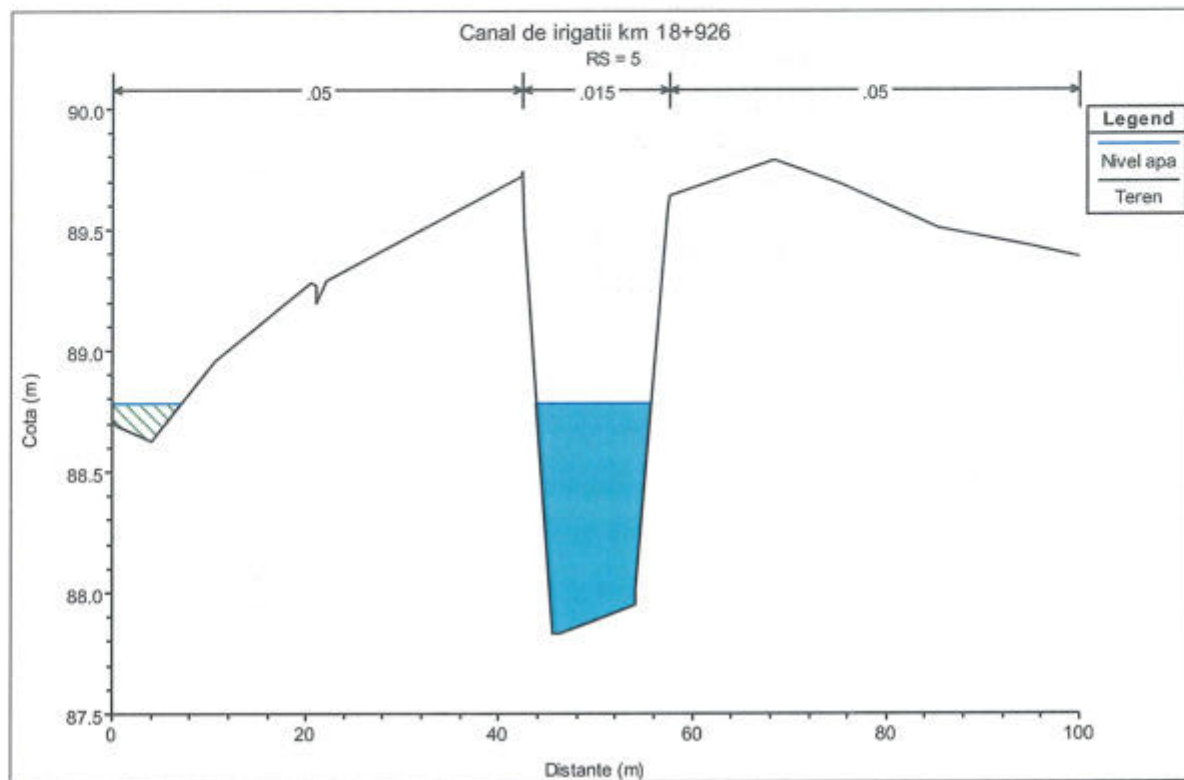
Regim neamenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidraulică	Viteza (m/s)	Nr. Froude
6	12	88.81	0.000469	1.21	0.43
5	12	88.78	0.000594	1.33	0.48
4	12	88.69	0.001315	1.71	0.70
3	12	88.66	0.001601	1.81	0.76
2	12	88.66	0.000895	1.48	0.58
1	12	88.46	0.002944	2.19	1.01

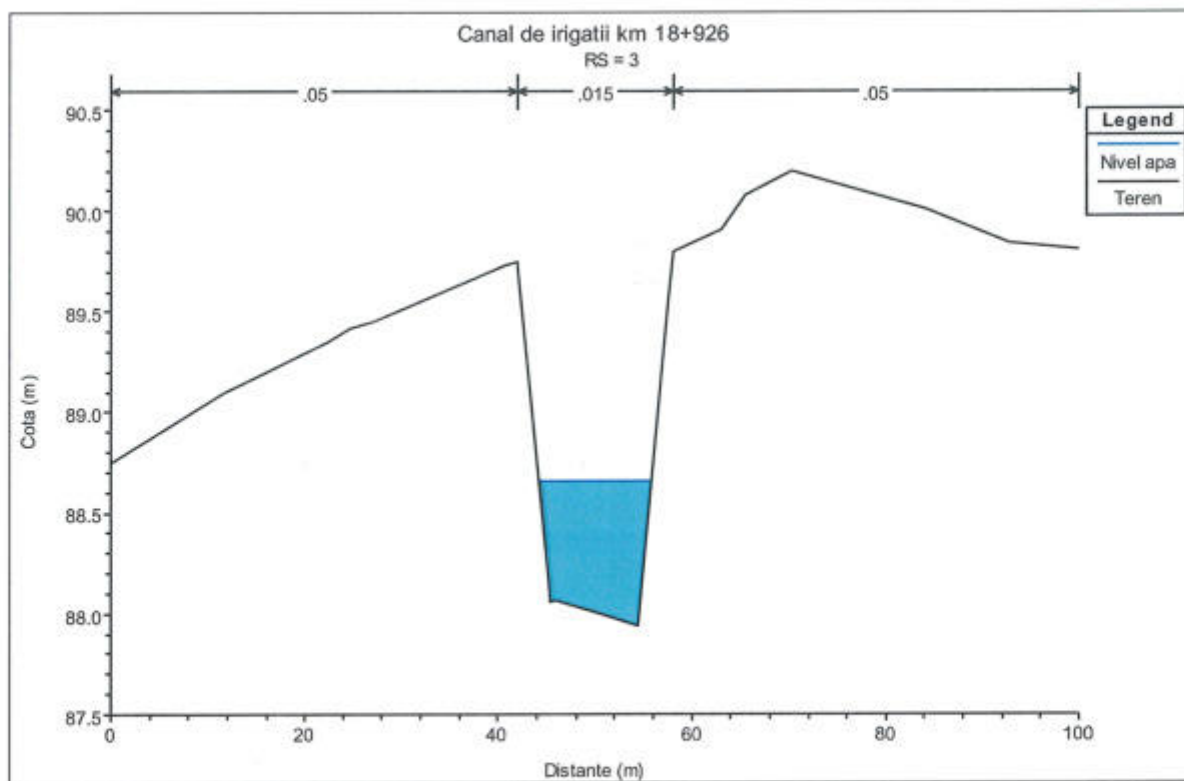
Profil longitudinal



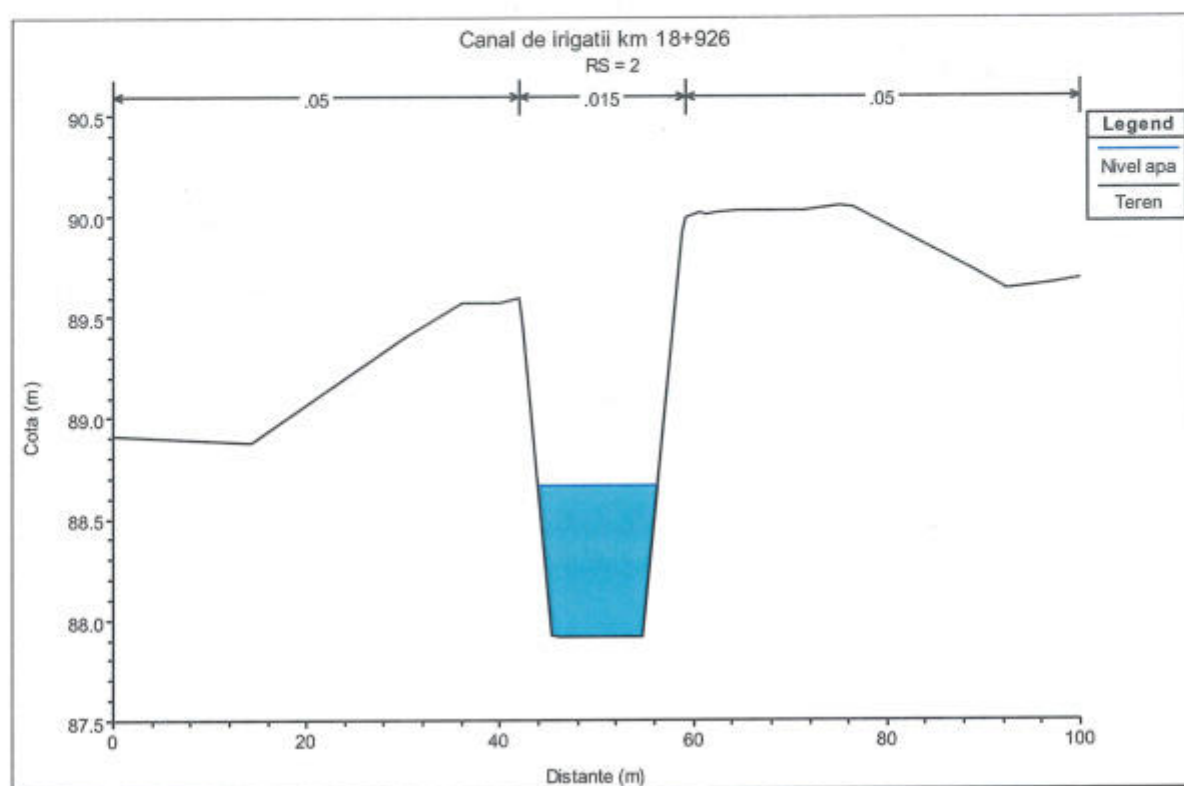
Secțiune transversală amonte de pod



Secțiune transversală în dreptul podului



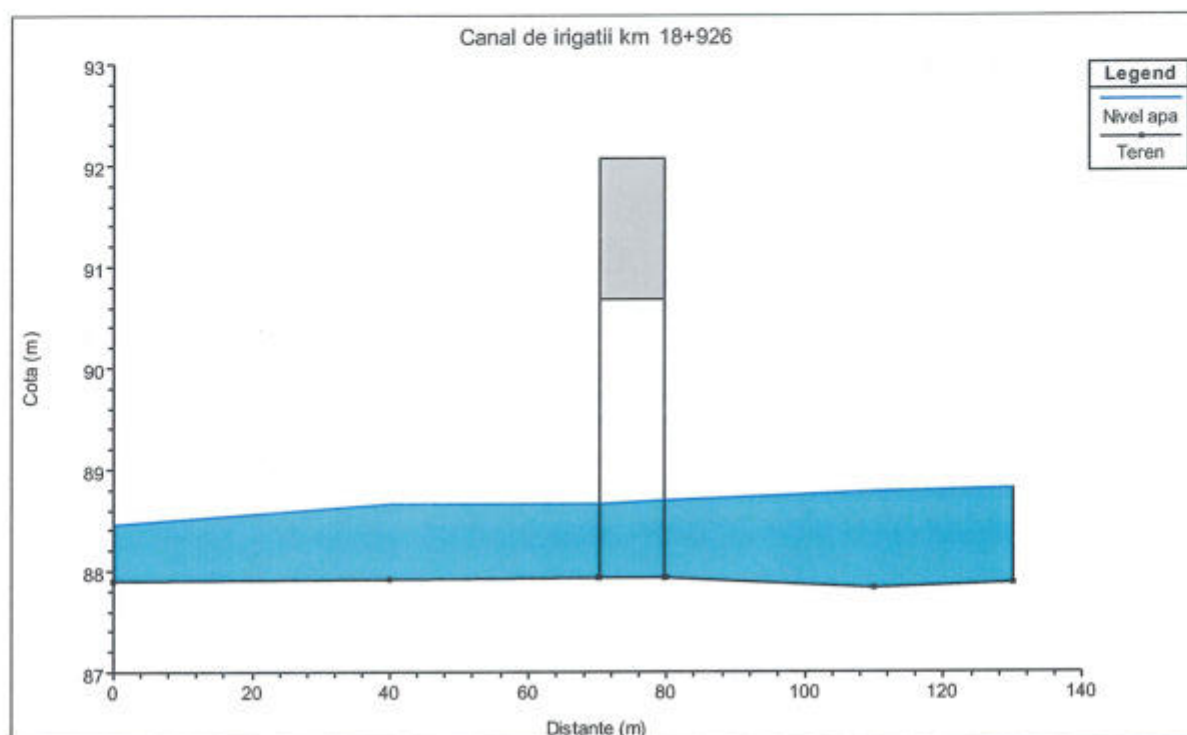
Secțiune transversală aval de pod



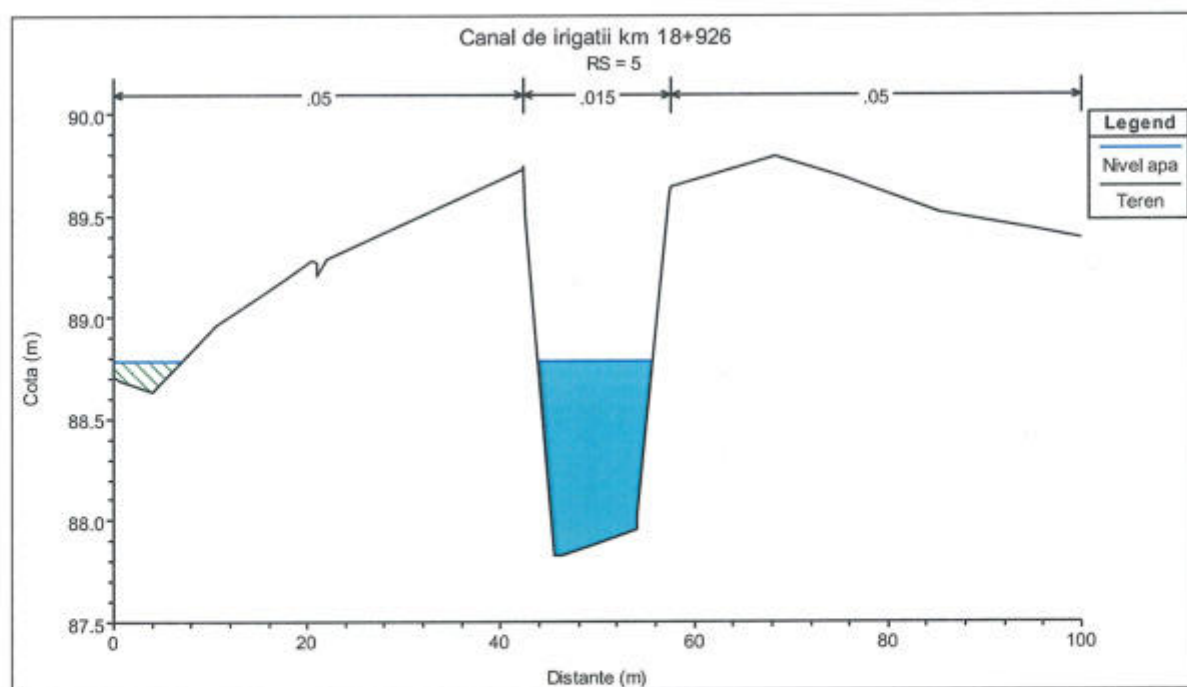
Regim amenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidraulică	Viteza (m/s)	Nr. Froude
6	12	88.81	0.000472	1.21	0.43
5	12	88.78	0.000598	1.33	0.49
4	12	88.69	0.001340	1.72	0.70
3.4	Pod				
3	12	88.66	0.001601	1.81	0.76
2	12	88.66	0.000895	1.48	0.58
1	12	88.46	0.002944	2.19	1.01

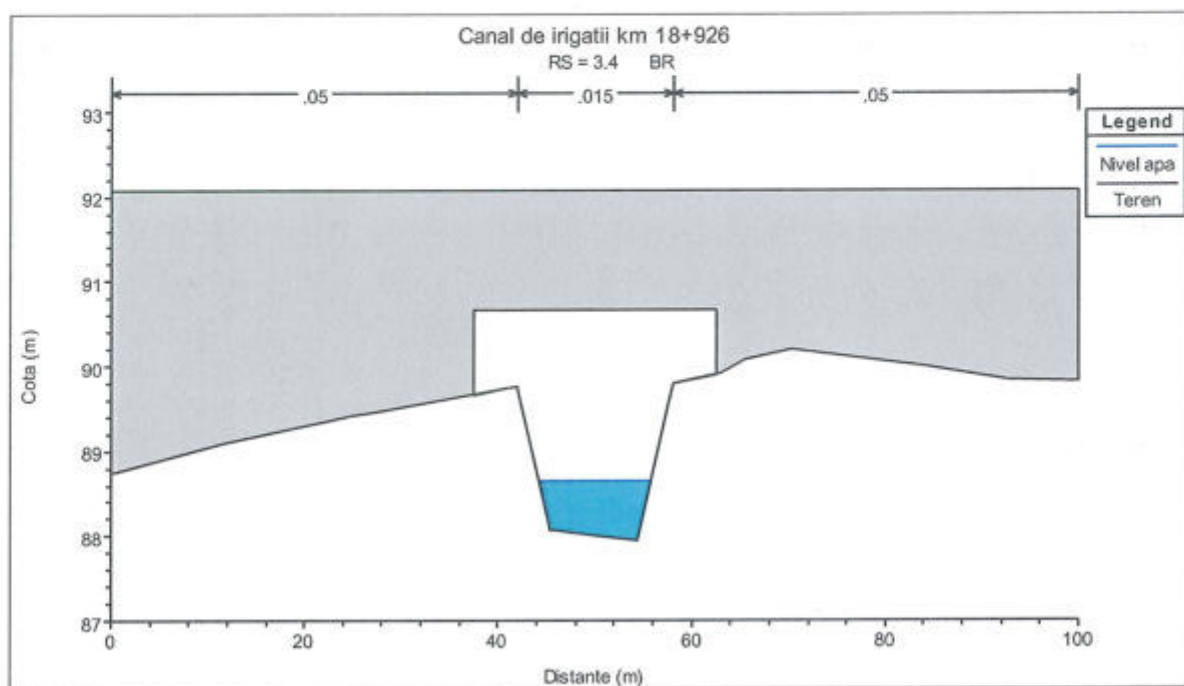
Profil longitudinal



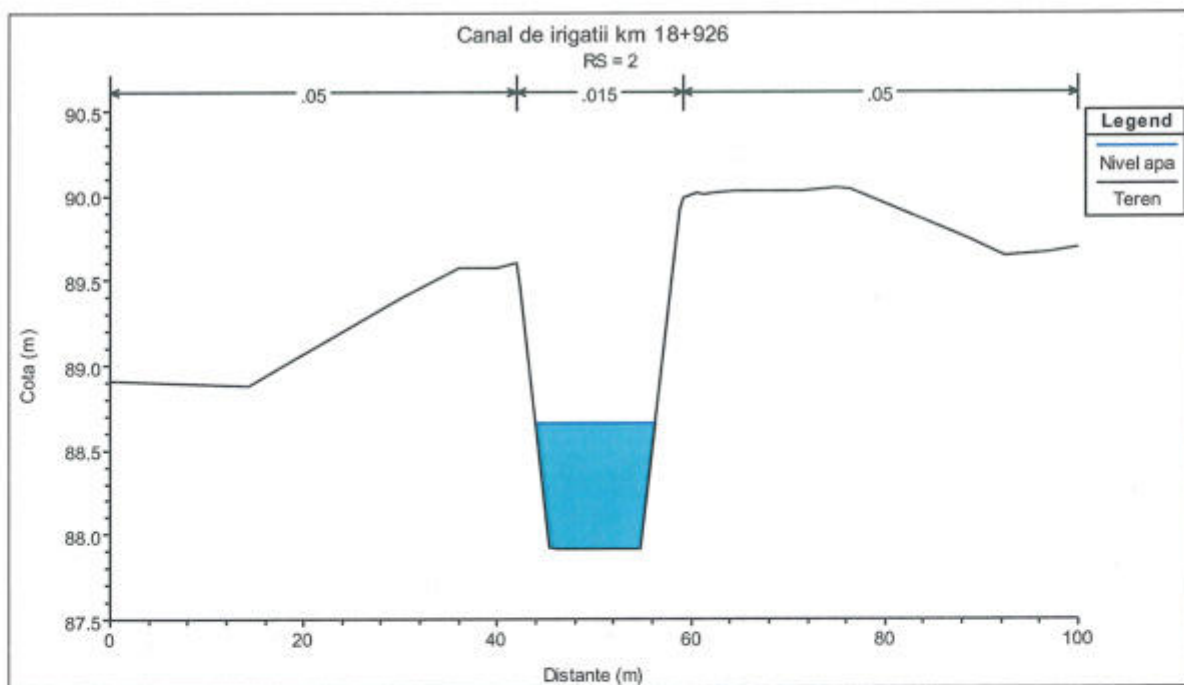
Secțiune transversală amonte de pod



Secțiune transversală în dreptul podului



Secțiune transversală aval de pod



Execuția podului nu modifică regimul de curgere a apei în canal.

Pentru debitul cu probabilitatea de depășire de 2% nivelul apei este 88,69 mdMN, față de 90,67mdMN cota intrados a podului, asigurându-se înălțimea liberă trecere sub pod de 1,98m.

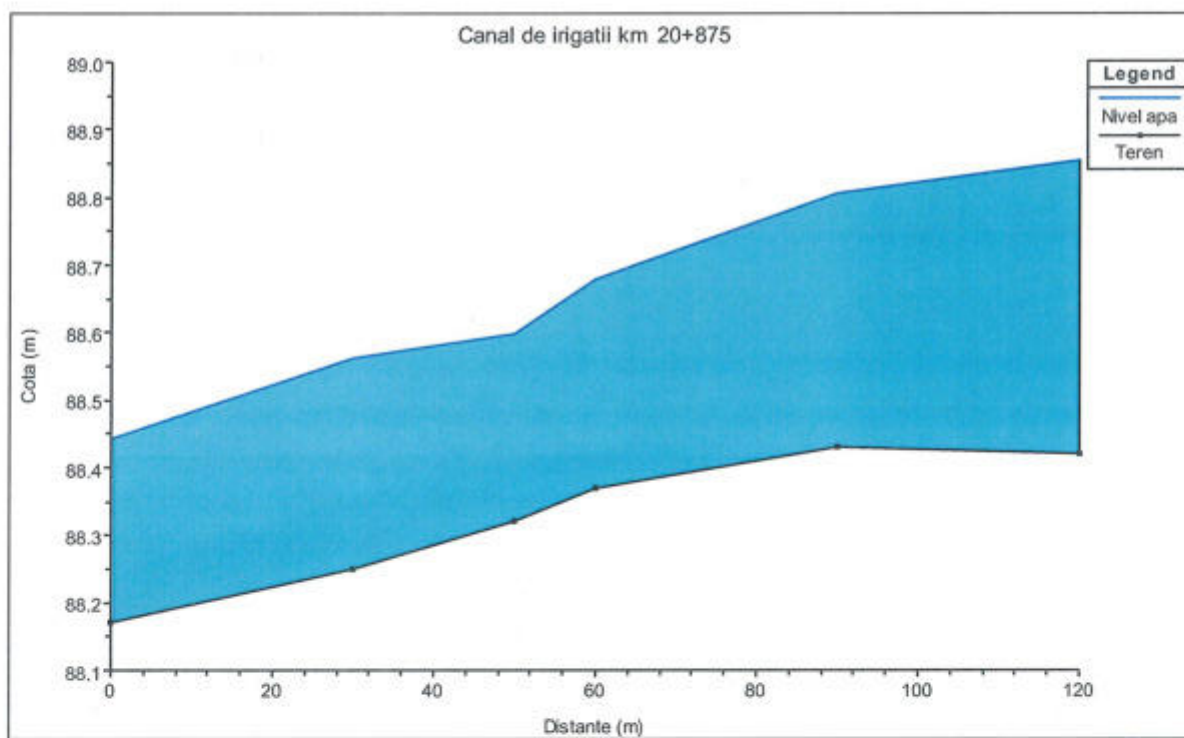
3.2. Pod peste canal de irigații km 20+875

Podul face un unghi de 40 de grade față de cursul de apă și are o singură deschidere de 40,70 m. Cota minimă a intradosului este 91,45 mdMN.

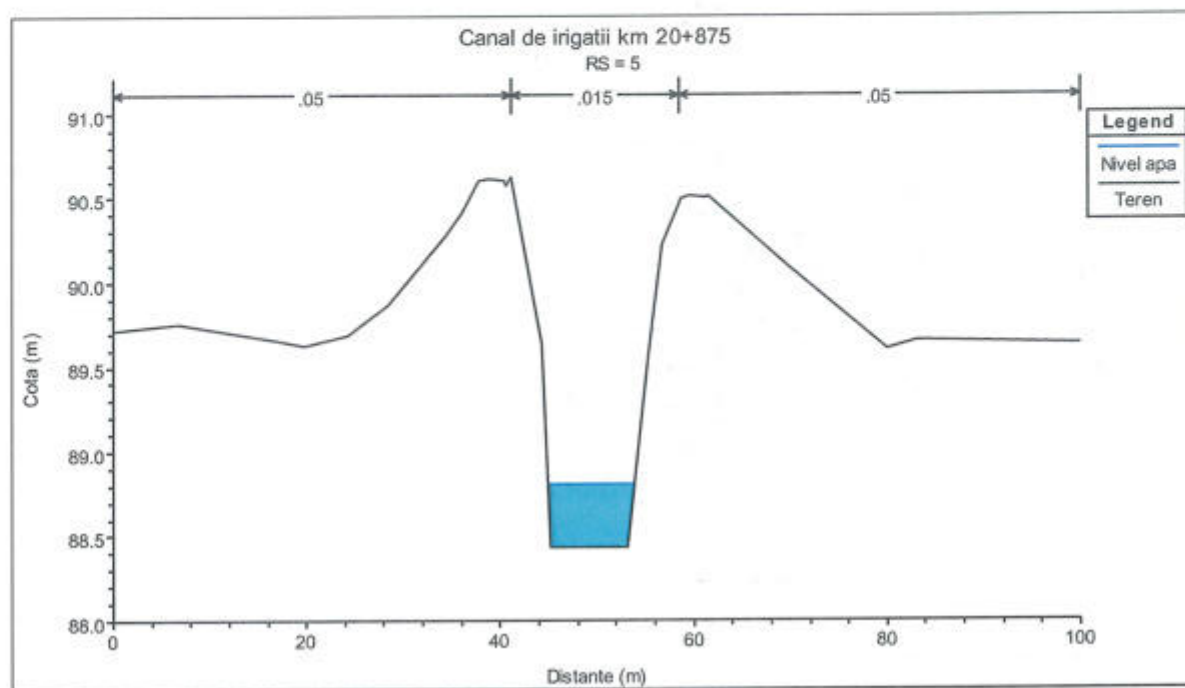
Regim neamenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidrolică (m/m)	Viteza (m/s)	Nr. Froude
6	3.56	88.85	0.000713	0.95	0.48
5	3.56	88.81	0.001161	1.12	0.60
4	3.56	88.68	0.003570	1.59	1.00
3	3.56	88.60	0.003630	1.62	1.01
2	3.56	88.56	0.002314	1.40	0.82
1	3.56	88.44	0.003582	1.60	1.01

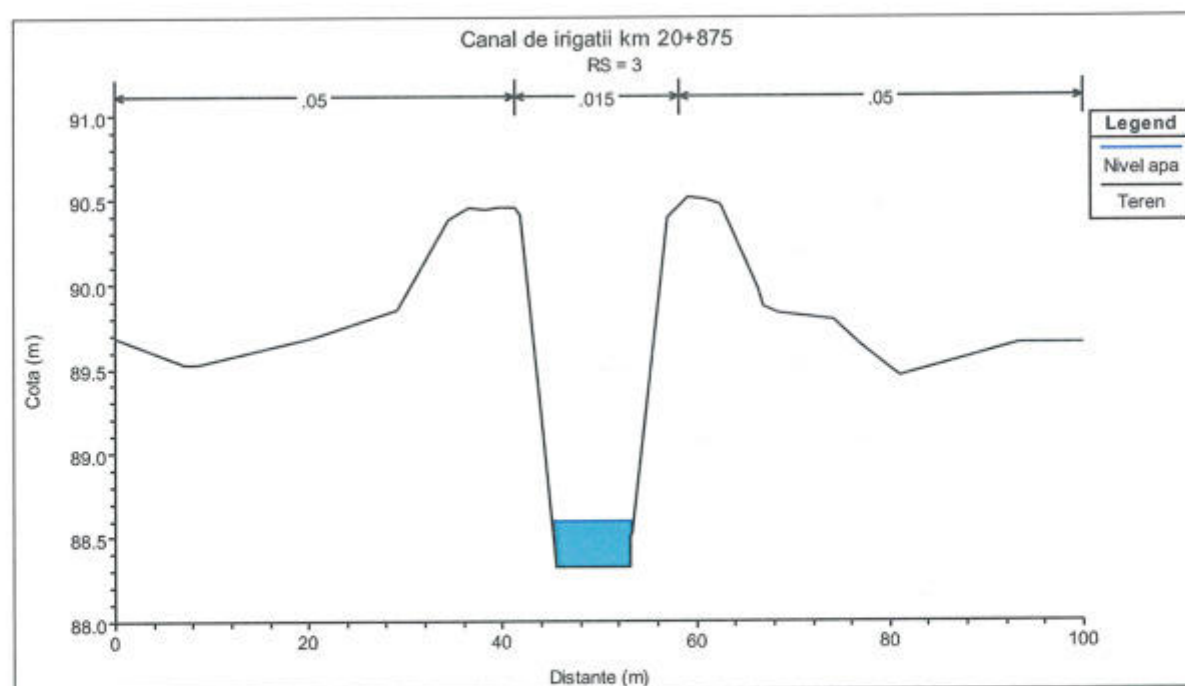
Profil longitudinal



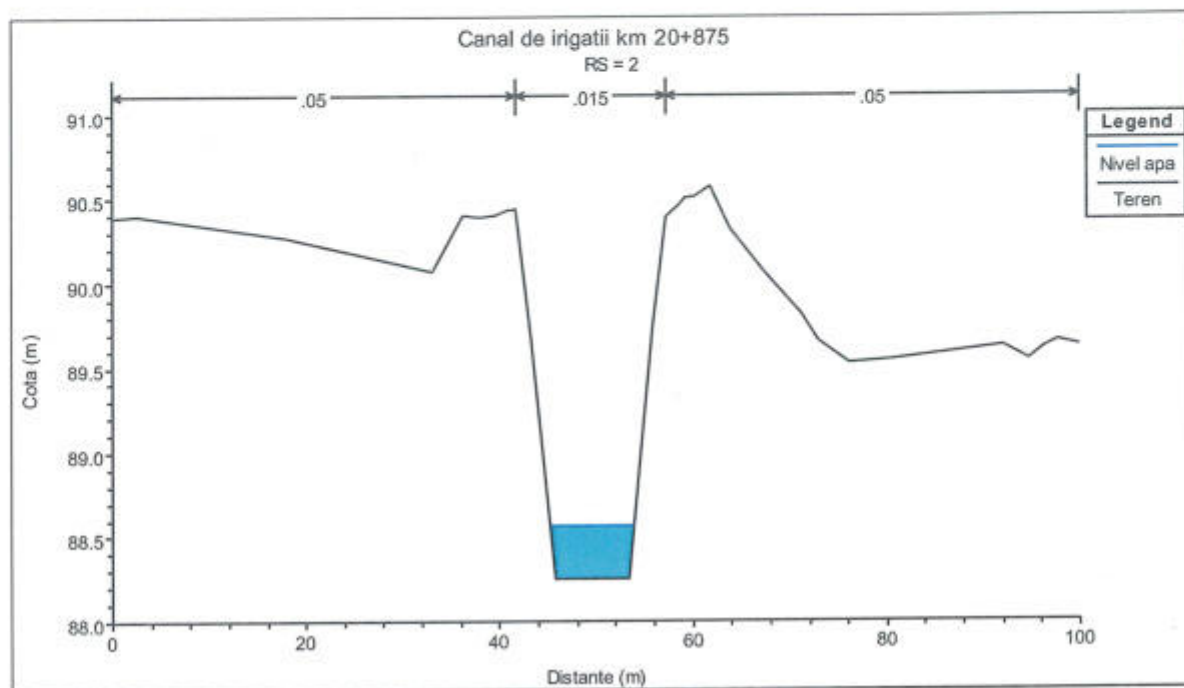
Secțiune transversală amonte de pod



Secțiune transversală în dreptul podului



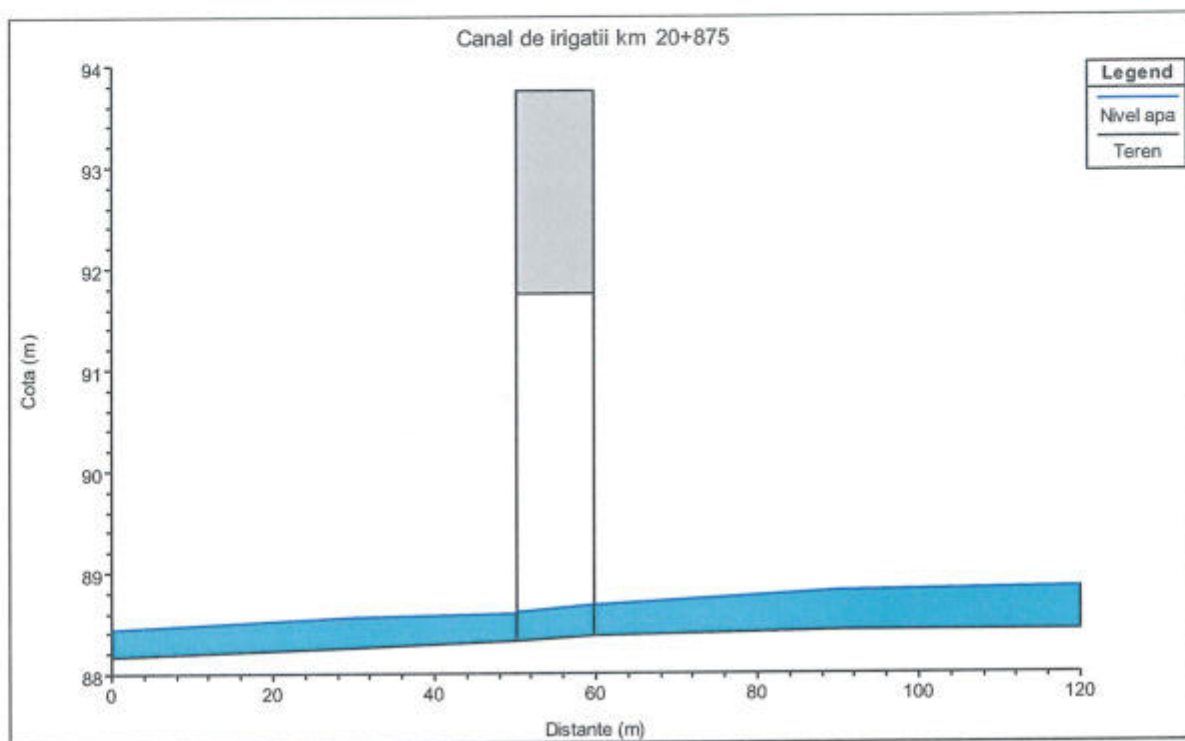
Secțiune transversală aval de pod



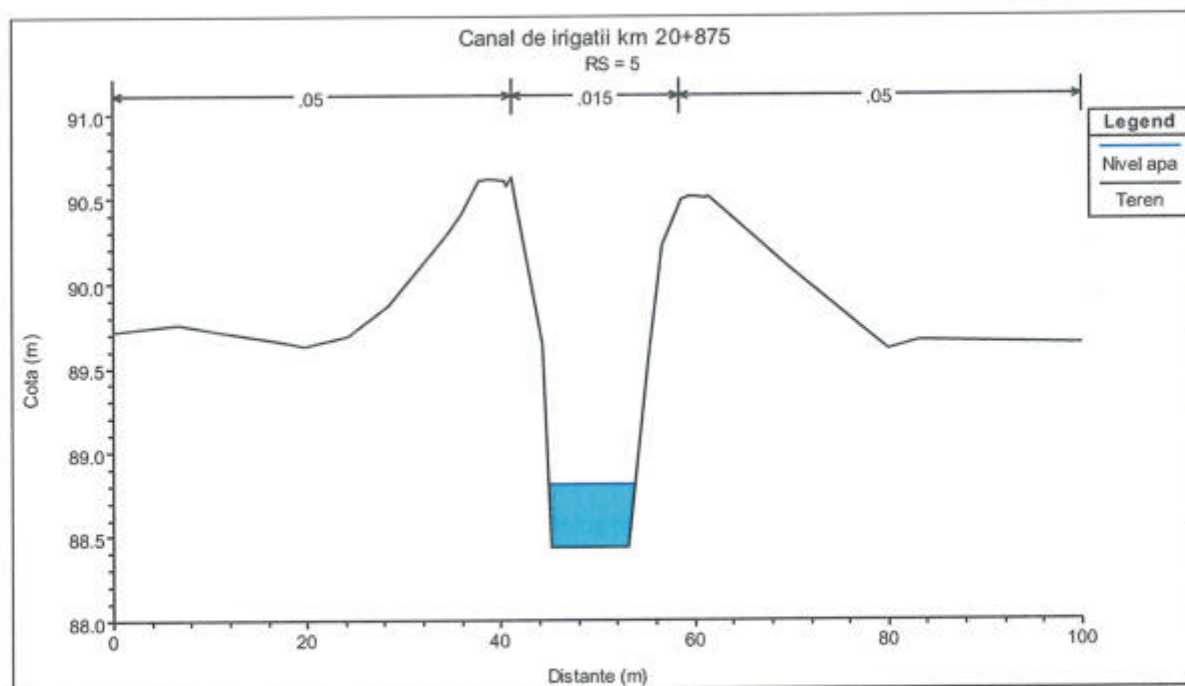
Regim amenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidrolică (m/m)	Viteza (m/s)	Nr. Froude
6	3.56	88.85	0.000717	0.95	0.48
5	3.56	88.81	0.001172	1.12	0.60
4	3.56	88.68	0.003445	1.57	0.99
3.4	Pod				
3	3.56	88.60	0.003622	1.62	1.00
2	3.56	88.56	0.002314	1.40	0.82
1	3.56	88.44	0.003582	1.60	1.01

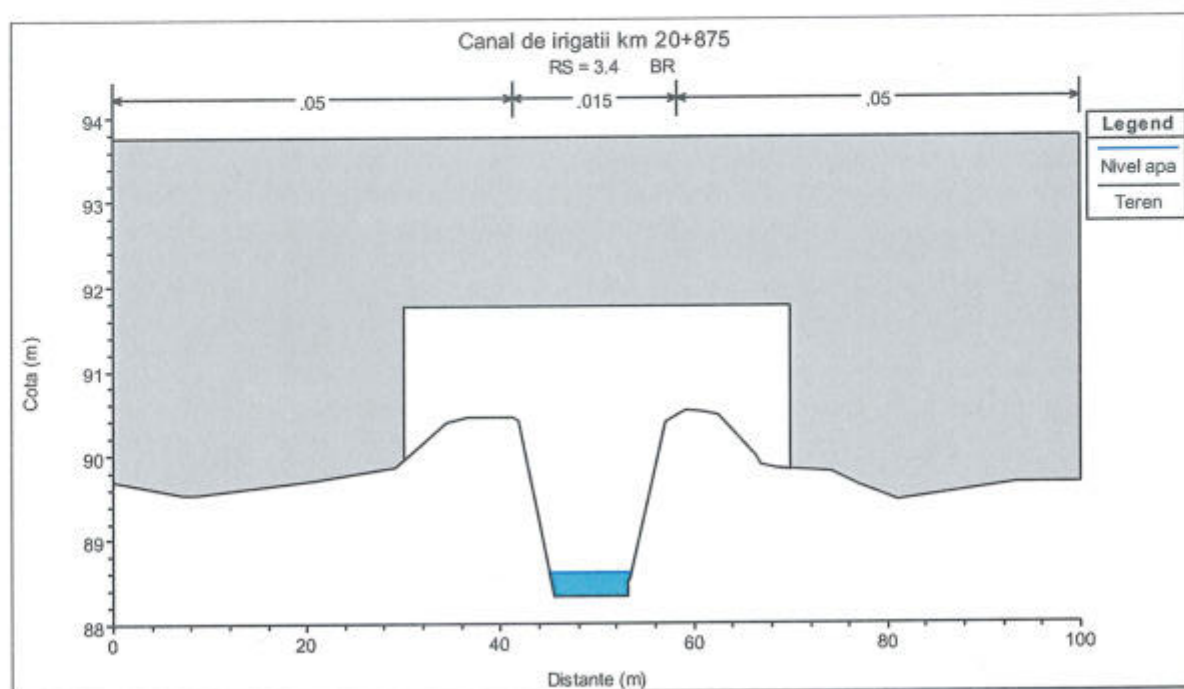
Profil longitudinal



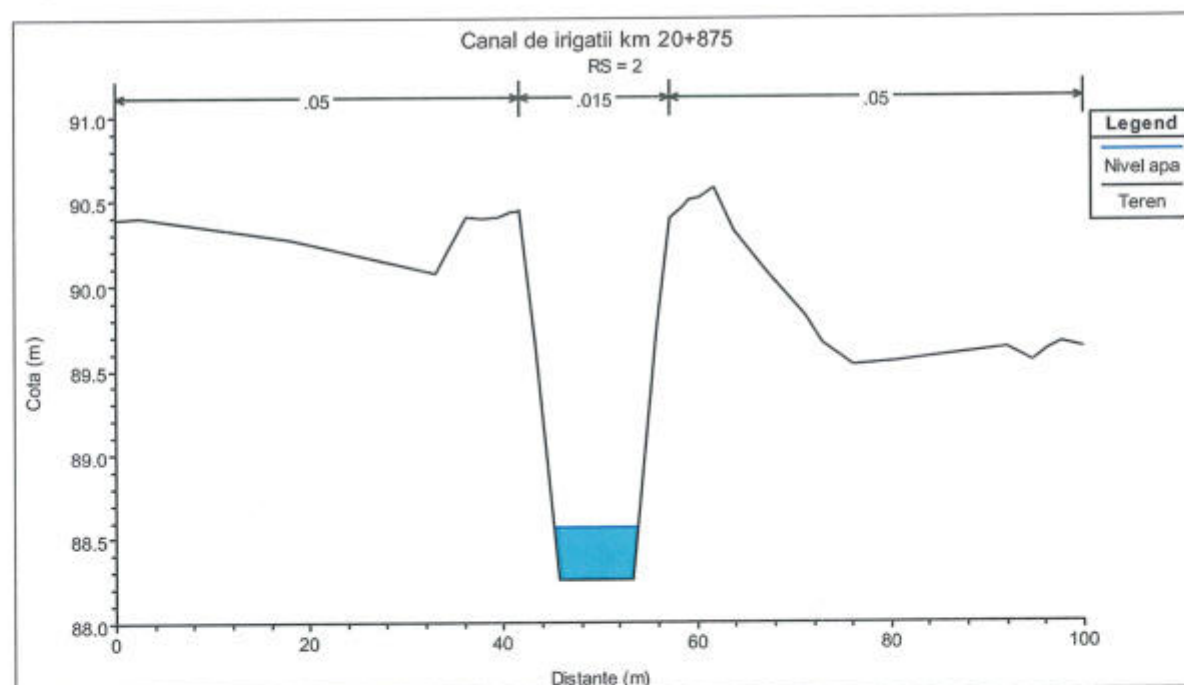
Secțiune transversală amonte de pod



Secțiune transversală în dreptul podului



Secțiune transversală aval de pod



Execuția podului nu modifică regimul de curgere a apei în canal.

Pentru debitul cu probabilitatea de depășire de 2% nivelul apei este 88,68 mdMN, față de 91,45mdMN cota intrados a podului, asigurându-se înălțimea liberă trecere sub pod de 2,77 m.

3.3. Pod peste canal Bega km 24+725

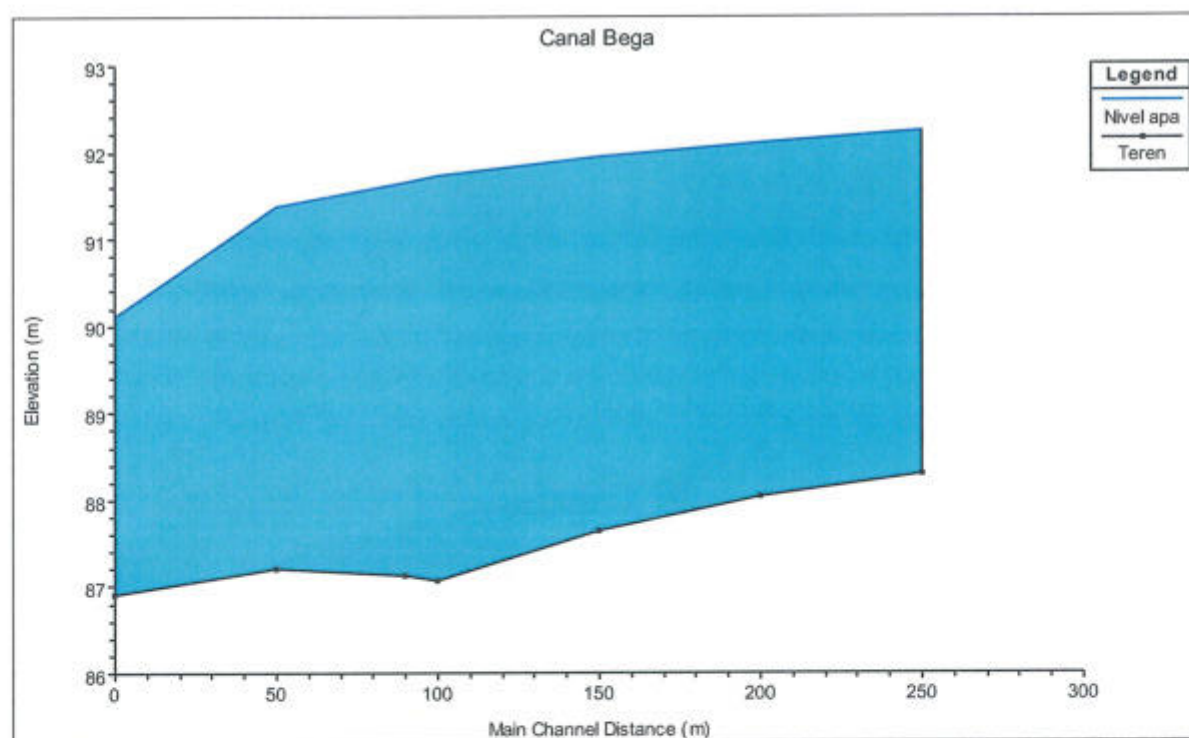
Podul are 5 deschideri 21,80+36,45+36,50+36,45+21,8 m.

Cota minimă a intradosului este 94,74 mdMN.

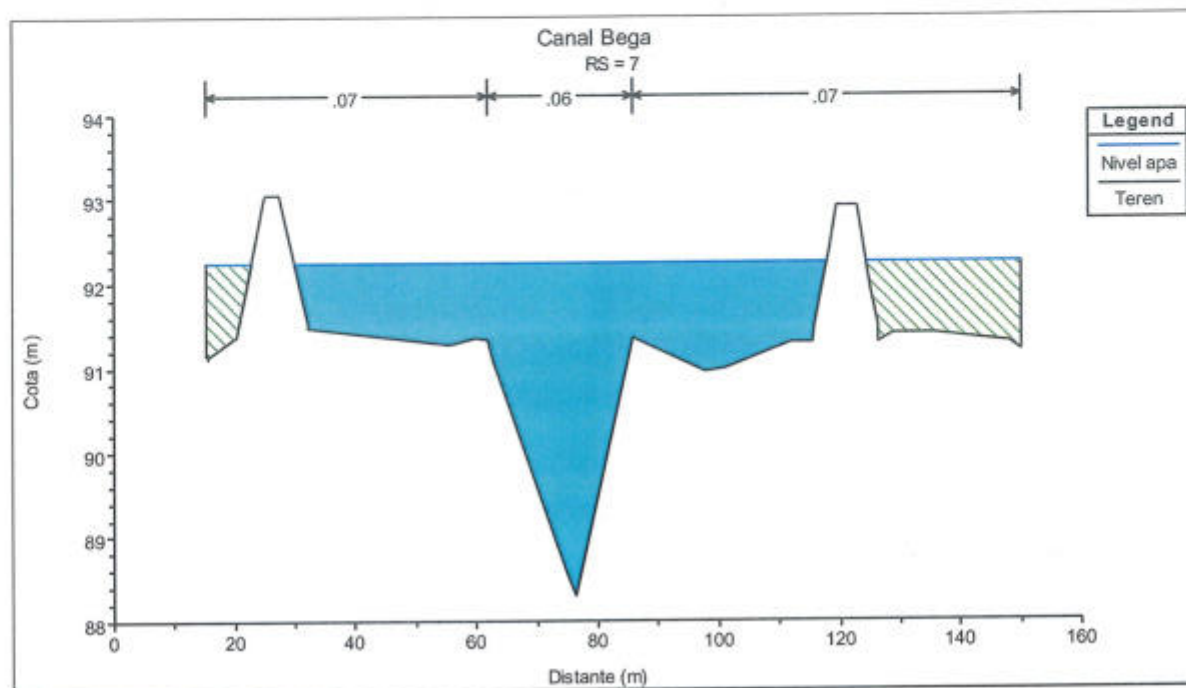
Regim neamenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidraulică (m/m)	Viteza (m/s)	Nr. Froude
7	100	92.24	0.001514	1.15	0.24
6	100	92.10	0.002483	1.45	0.30
5	100	91.95	0.002858	1.54	0.32
4	100	91.74	0.003769	1.76	0.36
3	100	91.65	0.005227	1.97	0.42
2	100	91.38	0.006367	2.13	0.46
1	100	90.11	0.033950	4.00	1.00

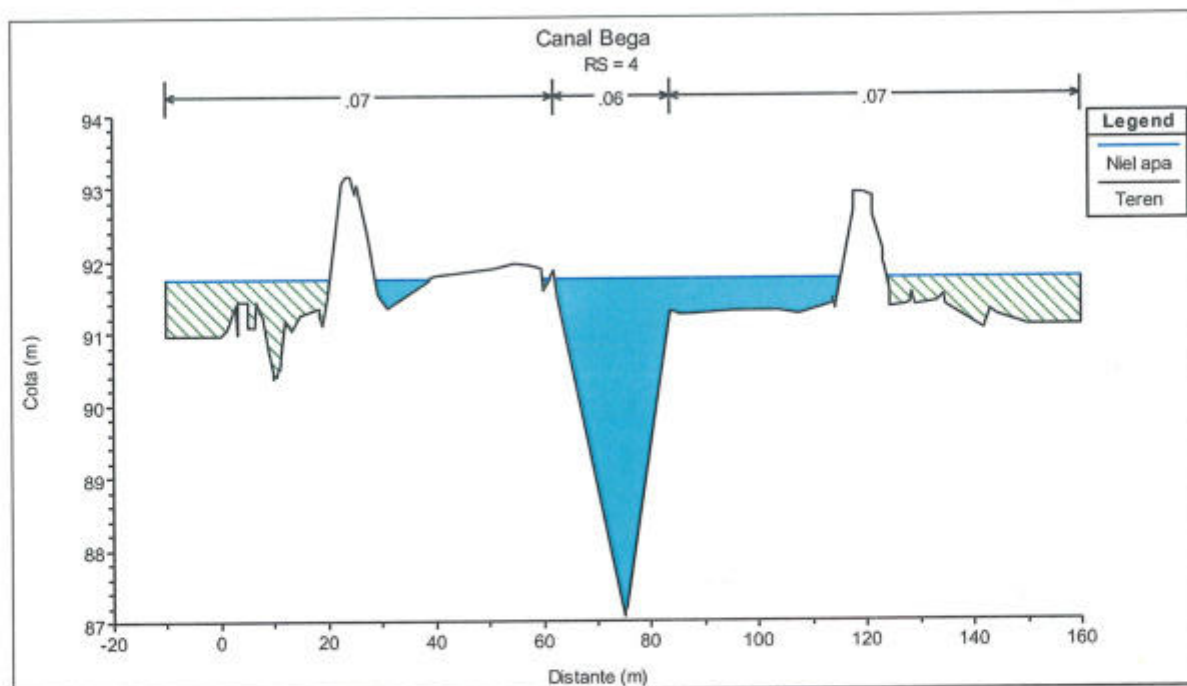
Profil longitudinal



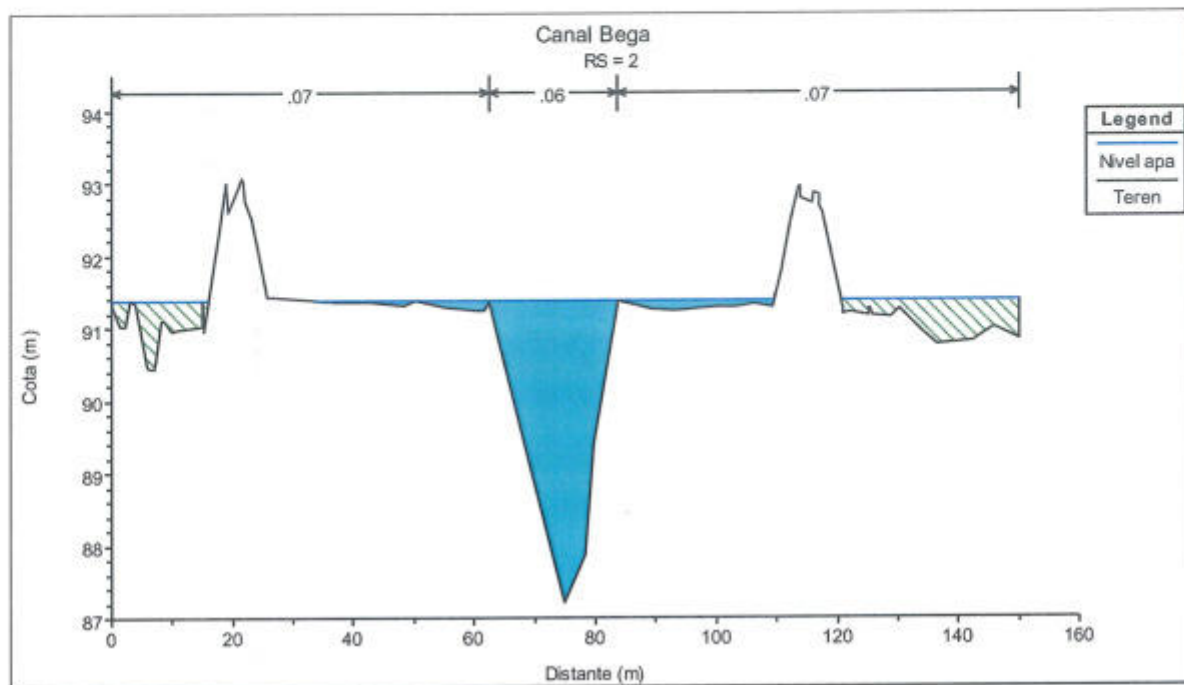
Secțiune transversală amonte de pod



Secțiune transversală în dreptul podului



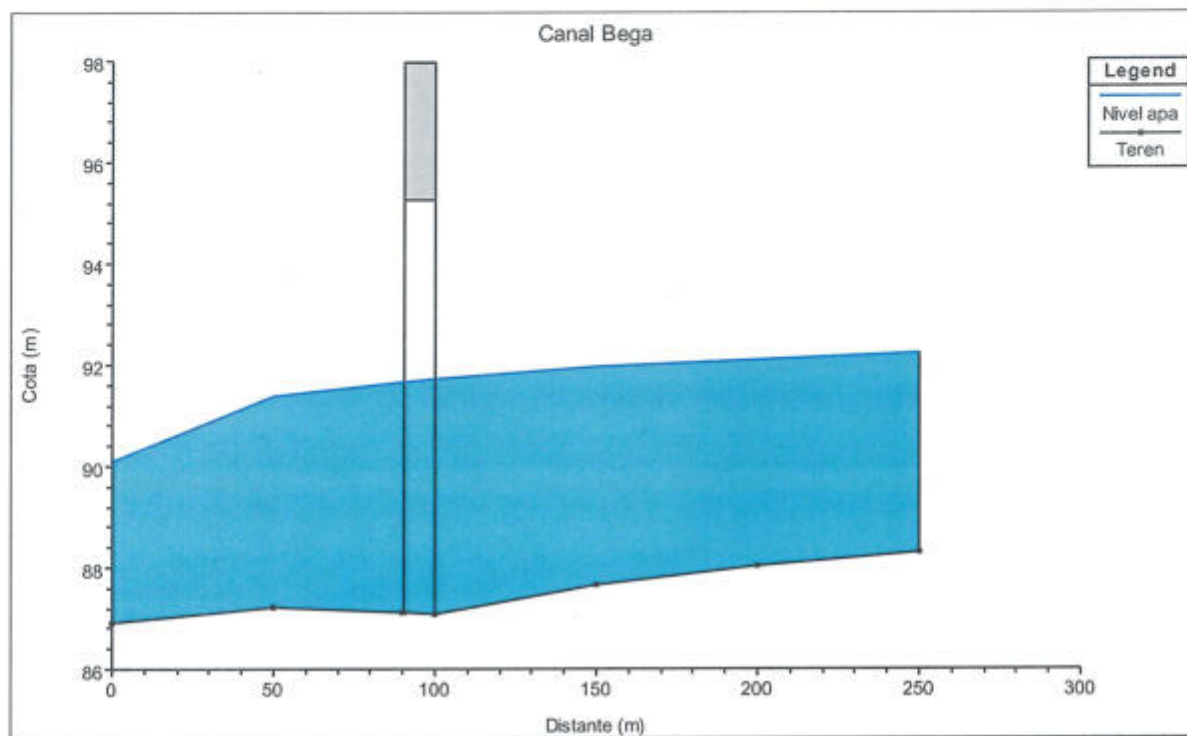
Secțiune transversală aval de pod



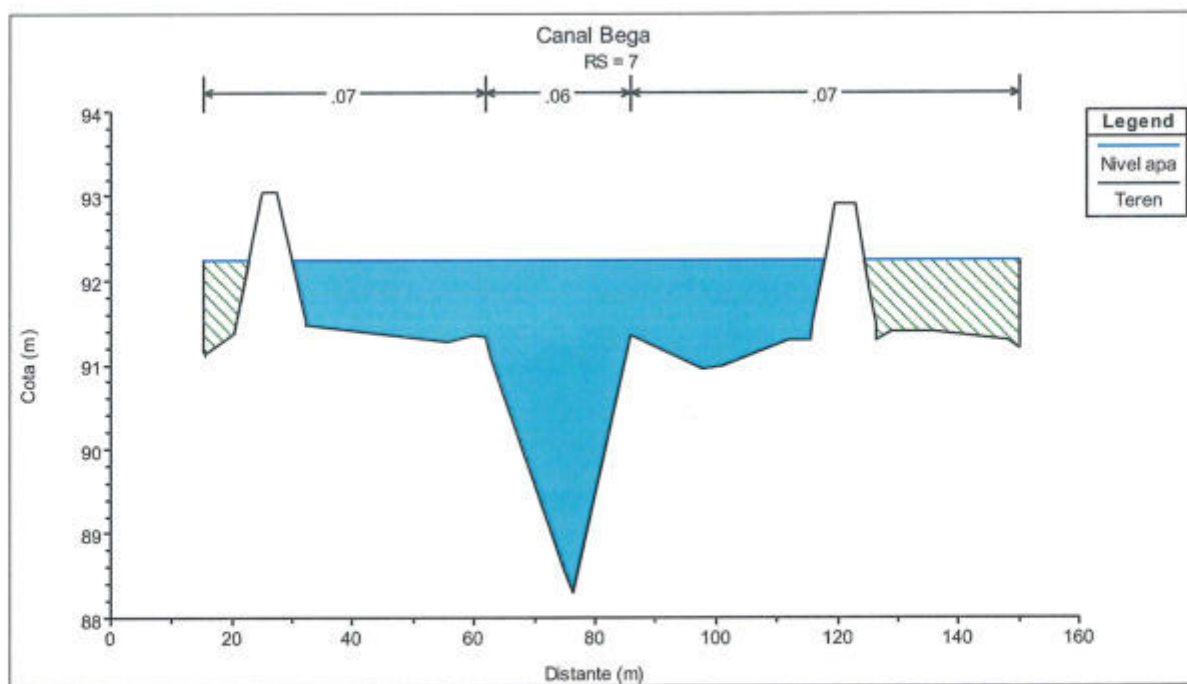
Regim amenajat

Numar profil	Q (m ³ /s)	Nivel apă (m)	Panta hidrolică (m/m)	Viteza (m/s)	Nr. Froude
7	100	92.24	0.001512	1.15	0.23
6	100	92.10	0.002478	1.45	0.30
5	100	91.95	0.002851	1.54	0.32
4	100	91.74	0.003756	1.75	0.36
3.4	Pod				
3	100	91.65	0.005227	1.97	0.42
2	100	91.38	0.006367	2.13	0.46
1	100	90.11	0.033950	4.00	1.00

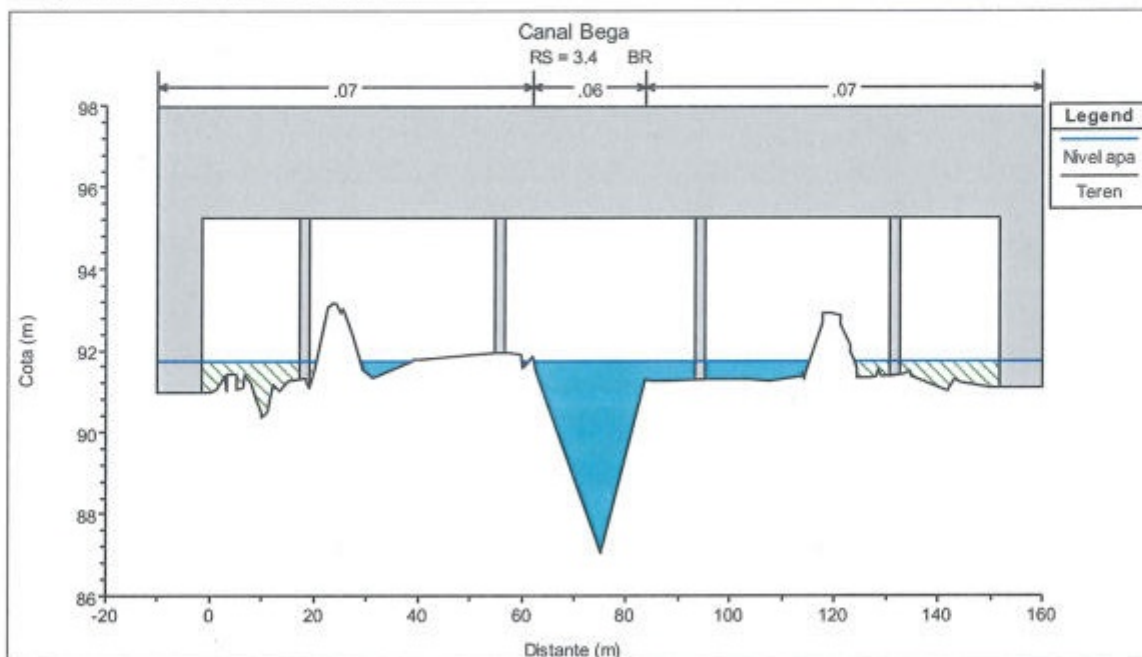
Profil longitudinal



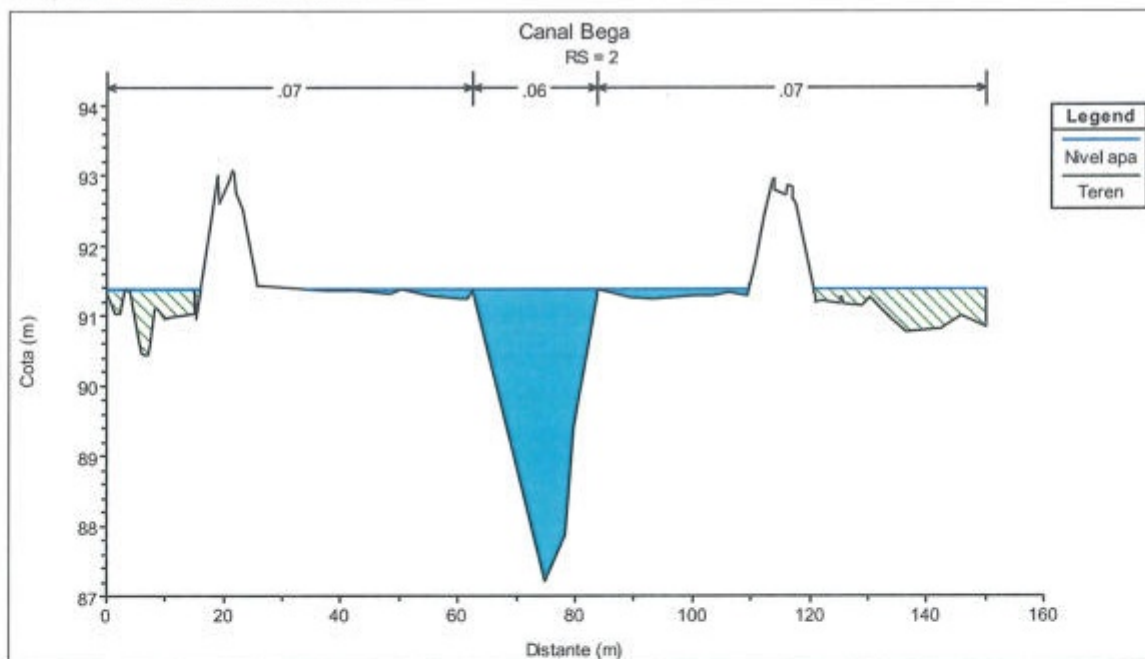
Secțiune transversală amonte de pod



Secțiune transversală în dreptul podului



Secțiune transversală aval de pod



Rezultă că pentru debitul cu probabilitatea de depășire de 2% nivelul apei este 91,74 mdMN, față de 94,74 mdMN cota intrados a podului, asigurându-se înălțimea liberă trecere sub pod de 3,00 m.

Întocmit
Ing. Doina Simescu

Verificat
Ing. Adrian Simescu