

Deformacje skorupy Ziemskiej

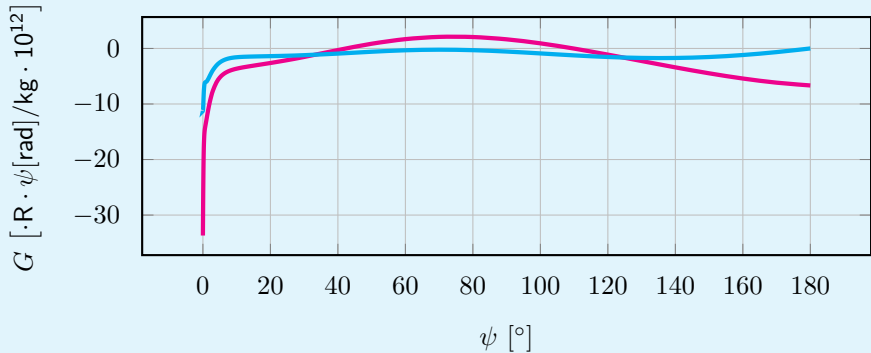
wersja z 11 kwietnia 2014

a) Obliczyć deformacje Ziemi (składowe h, n, e) w punkcie o zadanych współrzędnych $\varphi = 52^{\circ}0'0''$ i $\lambda = 21^{\circ}0'0''$.

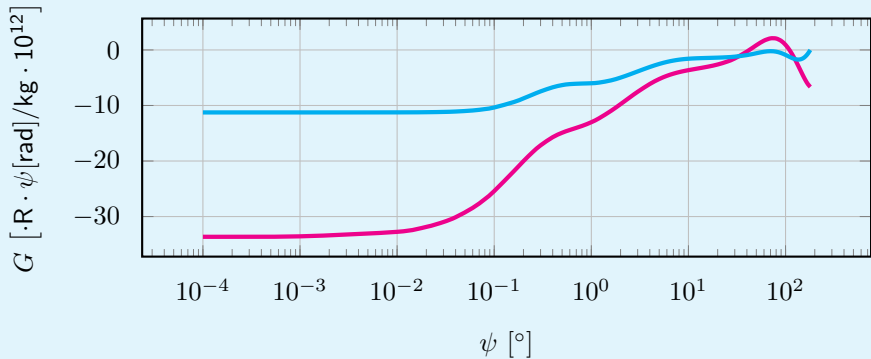
Armia niemiecka	Armia Czerwona		kg
900 000	1 336 000	żołnierzy	80
10 000	19 100	moździerzy	200
2700	3444	czołgów	30 000
2500	2900	samolotów	10 000
		Σ	370 100 000
		\times	1000
		$\Sigma \times$	370 100 000 000

ψ [°]	G_r [°]	G_h [°]
0.0001	-33.640	-11.250
0.001	-33.560	-11.250
0.01	-32.750	-11.240
0.02	-31.860	-11.210
0.03	-30.980	-11.160
0.04	-30.120	-11.090
0.06	-28.440	-10.900
0.08	-26.870	-10.650
0.1	-25.410	-10.360
0.16	-21.800	-9.368
0.2	-20.020	-8.723
0.25	-18.360	-8.024
0.3	-17.180	-7.467
0.4	-15.710	-6.725
0.5	-14.910	-6.333
0.6	-14.410	-6.150
0.8	-13.690	-6.050
1	-13.010	-5.997

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$$G_r = \frac{a}{m} \cdot \sum_1^{\infty} h'_n \cdot P_n(\cos \psi)$$

$$G_h = \frac{a}{m} \cdot \sum_1^{\infty} l'_n \cdot \frac{\partial P_n(\cos \psi)}{\partial \psi} \cdot (-\cos \alpha, -\sin \alpha)$$

ψ [°]	G_r [°]	G_h [°]
1.2	-12.310	-5.881
1.6	-10.950	-5.475
2	-9.757	-4.981
2.5	-8.519	-4.388
3	-7.533	-3.868
4	-6.131	-3.068
5	-5.237	-2.523
6	-4.660	-2.156
7	-4.272	-1.915
8	-3.999	-1.754
9	-3.798	-1.649
10	-3.640	-1.582
12	-3.392	-1.504
16	-2.999	-1.435
20	-2.619	-1.386
25	-2.103	-1.312
30	-1.530	-1.211
40	-0.292	-0.926

ψ [°]	G_r [°]	G_h [°]
50	0.848	-0.592
60	1.676	-0.326
70	2.083	-0.223
80	2.057	-0.310
90	1.643	-0.555
100	0.920	-0.894
110	-0.025	-1.247
120	-1.112	-1.537
130	-2.261	-1.706
140	-3.405	-1.713
150	-4.476	-1.540
160	-5.414	-1.182
170	-6.161	-0.657
180	-6.663	0.000

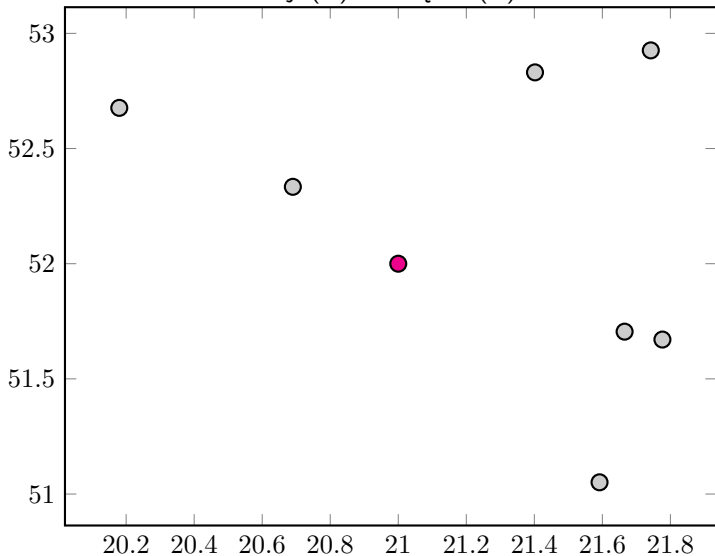
- Dane do zadania

Wykaz 1: Dane do zadania

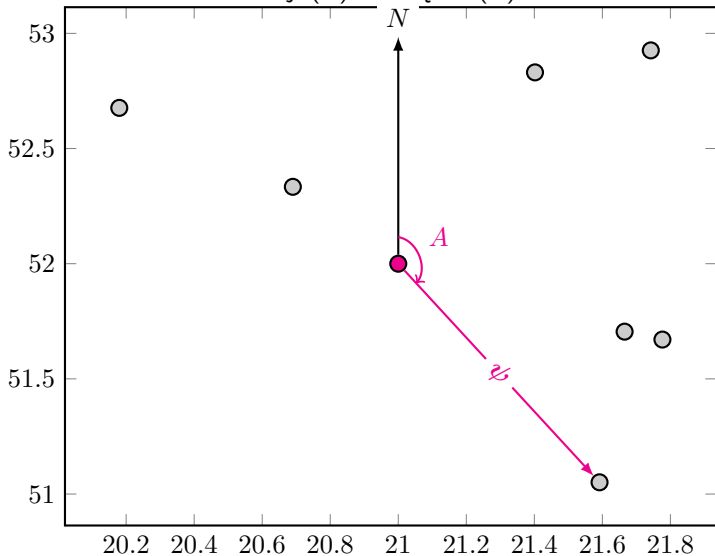
# nr	fi [st dz]	la [st dz]	masa [kg]
0	51.05096	21.59173	122699927392.4
0	51.70503	21.66539	50141476421.7
0	52.33383	20.69009	8304866387.0
0	52.92611	21.74237	151704279735.2
0	52.67658	20.17984	16312927202.9
0	51.67071	21.77657	6733961634.0
0	52.83065	21.40196	14202572234.7

(indywidualne dane do zadania na końcu prezentacji)

• Rozmieszczenie stacji (●) i obciążeń (○).

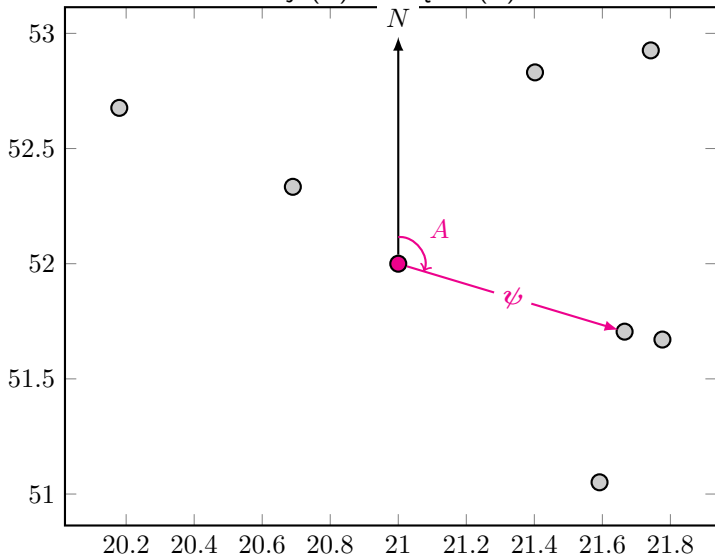


- Rozmieszczenie stacji (●) i obciążeń (○).

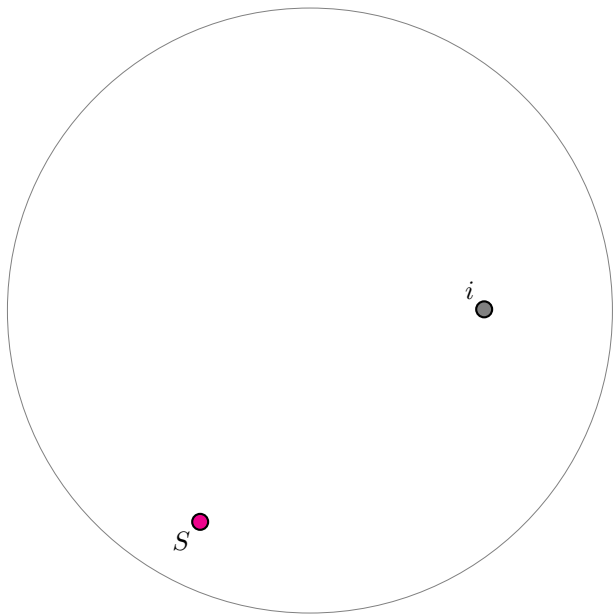


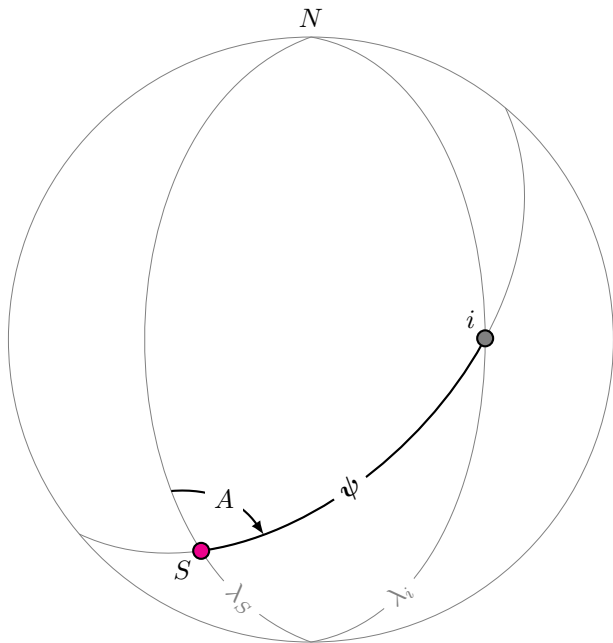
Z wzorów trygonometrii sferycznej

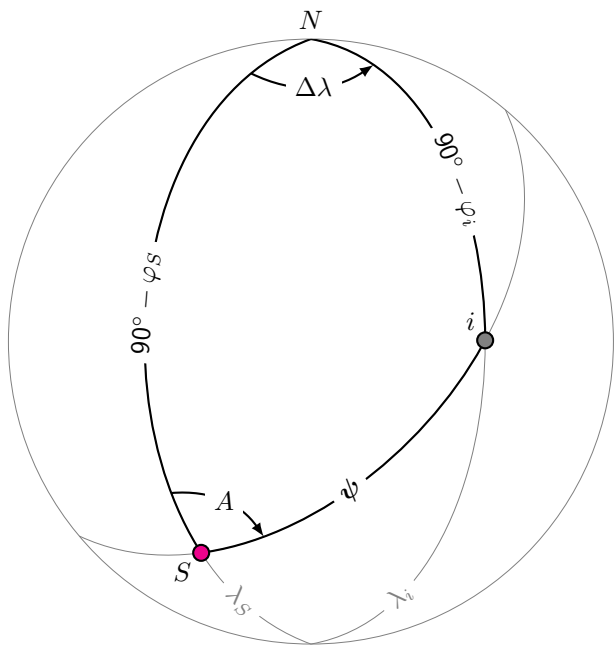
- Rozmieszczenie stacji (●) i obciążeń (○).



Z wzorów trygonometrii sferycznej







N

$$\psi = 2 \arcsin \left(\sqrt{\sin^2 \left(\frac{\Delta\varphi}{2} \right) + \cos \varphi_S \cos \varphi_i \sin^2 \left(\frac{\Delta\lambda}{2} \right)} \right)$$

lub

$$\psi = \arccos \left(\sin \varphi_S \sin \varphi_i + \cos \varphi_S \cos \varphi_i \cos \Delta\lambda \right)$$

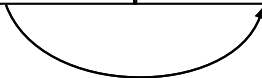
$$A = \operatorname{arctg} \left(\frac{\cos(\varphi_S) \cos(\varphi_i) \sin(\Delta\lambda)}{\sin(\varphi_S) - \cos(\psi) \sin(\varphi_i)} \right)$$

lub

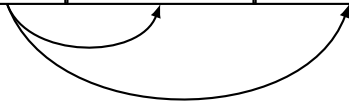
$$A = \arcsin \left(\frac{\cos \varphi_i \cdot \sin \Delta\lambda}{\sin \psi} \right)$$

φ [°]	λ [°]
51,05096	21,59173
51,70503	21,66539
52,33383	20,69009
52,92611	21,74237
52,67658	20,17984
51,67071	21,77657
52,83065	21,40196

φ [°]	λ [°]	ψ [°]	A [°]
51,05096	21,59173	1,01790	158,57000
51,70503	21,66539	0,50589	125,40000
52,33383	20,69009	0,38415	330,46000
52,92611	21,74237	1,03060	25,73700
52,67658	20,17984	0,84194	323,80000
51,67071	21,77657	0,58197	124,15000
52,83065	21,40196	0,86607	16,28500



$\psi [^\circ]$	$G_r [\cdot 10^{12} \cdot \psi \cdot R]$	$G_h [\cdot 10^{12} \cdot \psi \cdot R]$
1, 01790	-12, 94800	-5, 98960
0, 50589	-14, 87500	-6, 31760
0, 38415	-15, 88500	-6, 81490
1, 03060	-12, 90400	-5, 98390
0, 84194	-13, 55000	-6, 04190
0, 58197	-14, 48800	-6, 17260
0, 86607	-13, 46800	-6, 03680



M [kg]	A [°]	G_r [$\cdot 10^{12} \cdot \psi \cdot R$]	G_h [$\cdot 10^{12} \cdot \psi \cdot R$]
122 699 900 000	158, 57000	-12, 94800	-5, 98960
50 141 480 000	125, 40000	-14, 87500	-6, 31760
8 304 866 000	330, 46000	-15, 88500	-6, 81490
151 704 300 000	25, 73700	-12, 90400	-5, 98390
16 312 930 000	323, 80000	-13, 55000	-6, 04190
6 733 962 000	124, 15000	-14, 48800	-6, 17260
14 202 570 000	16, 28500	-13, 46800	-6, 03680

$$\Delta r = \sum_{i=1}^n G_{r_i} \cdot M_i \quad \Delta h_{n,e} = \sum_{i=1}^n G_{h_i} \cdot M_i \cdot \left\{ \begin{array}{l} -\cos A \\ -\sin A \end{array} \right\}$$