PROIECT

STRUCTURI DIN BETON ARMAT II

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Anul IV, Grupa 32401/b

CBA II – TEMA PROIECTULUI

Să se proiecteze structura în cadre din beton armat monolit, pentru clădirea prezentată mai jos.

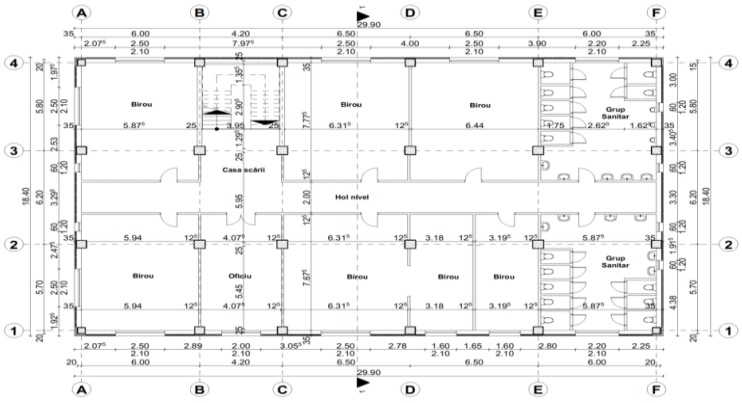
Date

n – numărul de ordine
l_1=3.80+0.05×n [m]
l_2=3.10+0.10×n [m]
t_1=5.80-0.05×n [m]
t_2=5.00-0.05×n [m]
[Amplasament]

q_n = 3.8-0.05×n [kN/m²] – încărcare utilă
regim de înălțime: P + 4E
$h_{1,util}$=4.00 [m] – înălțimea utilă a parterului
$h_{2,util}$=3.20 [m] – înălțimea utilă la etaje

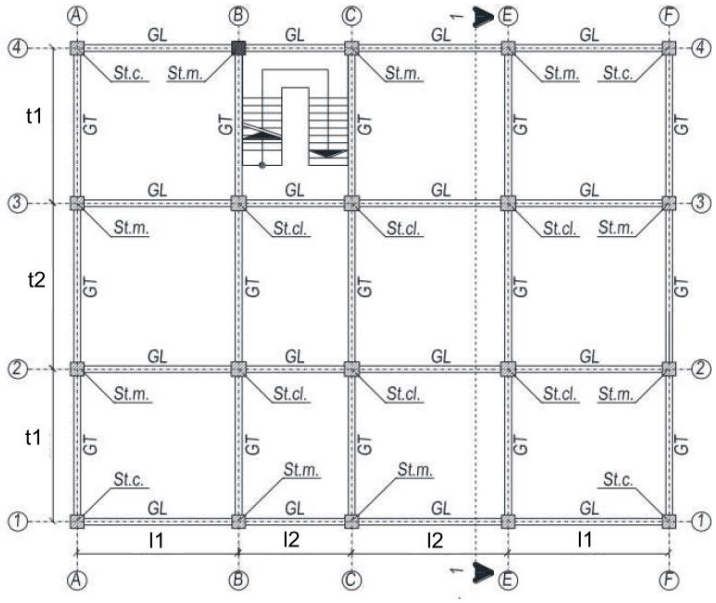
Clădirea studiată se află în localitatea [Amplasament], având structură în cadre, dispuse pe cele două direcții ortogonale. În plan are forma dreptunghiulară cu trei deschideri (T1, T2, T1) pe direcția transversală și

4 deschideri (L1, L2, L2, L1) pe direcția longitudinală.



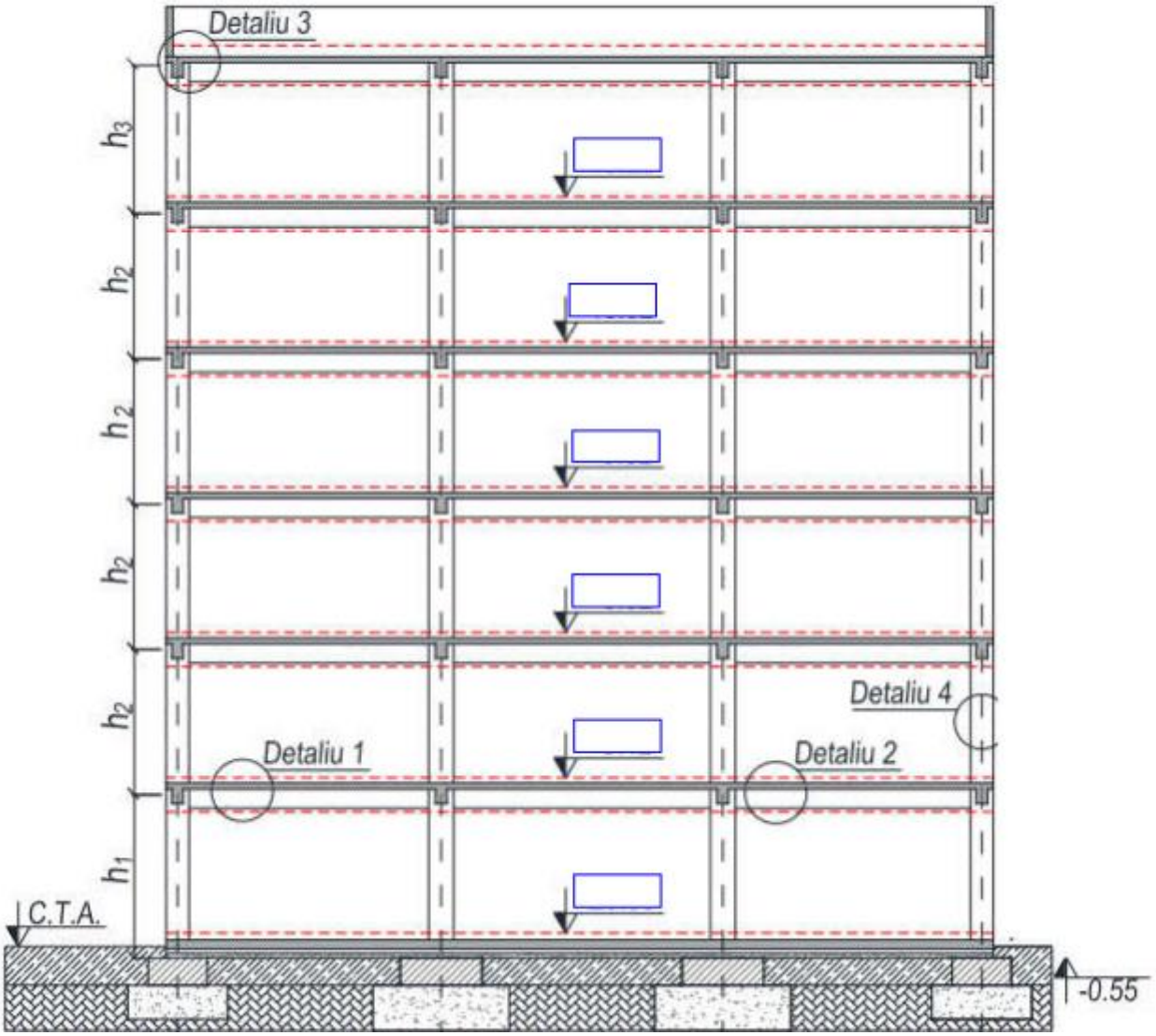
[Exemplu compartimentare]

Structura prezintă regularitate în plan și pe elevație, cum este schematizată în figura urmatoare.



Planșeul se va realiza în varianta de placă rezemată pe grinzi amplasate pe cele două direcții, susținute de stâlpi la intersecția acestora.
Compartimentările interioare se vor realiza utilizând sisteme de pereți cu plăci de gipscarton și schelet metalic având greutate maximă de 60 kg/m^2, lâsând posibilitatea recompartimentării în mod aleatoriu.

Înălțimile de nivel rezultă din cerințele înălțimilor libere de la parter și etaj ($h_{1,util}$ *și* $h_{2,util}$*).*



[Secțiune transversală 1-1]

Se cere:

- Stabilirea detaliilor arhitecturale pentru planșeu curent, planșeu terasă, pereți exteriori, pereți interiori și desenele aferente
- Predimensionarea elementelor structurale (plăci, grinzi, stâlpi)
- Evaluarea încărcărilor permanente [SR EN 1991-1-1:2004, SR EN 1991-1-1/NA:2006]
- Evaluarea încărcărilor variabile: încărcări utile (valoarea este dată prin temă pentru nivel curent), zăpadă [CR 1-1-3/2012], vânt [CR 1-1-4/2012]
- Evaluarea încărcărilor accidentale: seism - forța tăietoare de bază [P 100-1/2013]
- Stabilirea ipotezelor de încărcări, grupări de acțiuni [CR 0 - 2012, SR EN 1990:2004, SR EN 1990:2004/A1:2006]

- Calcul static liniar al structurii de rezistență printr-o analiză MEF, inclusiv verificarea rezultatelor obținute cu metode simplificate
- Verificarea condițiilor de deplasări și deformații

- Dimensionarea plăcii curente
- Dimensionarea unei grinzi transversale nivel curent
- Dimensionarea unei grinzi longitudinale nivel curent
- Dimensionarea unui stâlp
- Dimensionare scară

- Realizarea desenelor de execuție (plan cofraj și plan armare) pentru elementele dimensionate

Observații:

1. Detaliile arhitecturale alese trebuie să îndeplinească cerințele de termo- și hidroizolare pentru amplasamentul dat, dar în același timp să fie simple, practice
2. Rezistența la foc impusă pentru planșeu este de minim *60 minute*, iar pentru stâlpi de 90 *minute*
3. Materialele utilizate pentru realizarea structurii vor respecta cerințele de performanță pentru asigurarea rezistenței, durabilității și a ductilității corespunzătoare.
4. Scara utilizată la întocmirea desenelor va fi 1:50, iar în cazul detaliilor 1:10 sau 1:20. Extrasele de armare vor fi întocmite cu respectarea standardului SR EN ISO 3766:2004/AC:200 (Desene de construcţii. Reprezentarea simplificată a armăturilor pentru beton).

Termene pentru predarea proiectului:

- Stabilire detalii planșeu, predimensionarea elementelor structurale, evaluarea încărcărilor: permanente, variabile (utile, zăpadă, vânt), accidentale: seism: *săptămâna 4. – notă*
- Ipoteze de încărcări, calcul static: *săptămâna 7. – Admis/Respins*
- Dimensionarea elementelor structurale (placă nivel curent, 1 grindă transversală, 1 grindă longitudinală, 1 stâlp, o rampă de scară): *săptămâna 12. – notă*
- Realizare desene de execuție: *săptămâna 14. – NOTĂ PROIECT*

Bibliografie

Puskás A., Virág J., Faur A.: Îndrumător pentru proiectarea structurilor în cadre din beton armat. Clasa de ductilitate medie

Documente normative

CR 0 - 2012	Cod de proiectare. Bazele proiectării construcțiilor.
SR EN 1990:2004 SR EN 1990:2004/A1:2006	Eurocod: Bazele proiectării structurilor. Anexa națională
SR EN 1991-1-1:2004 SR EN 1991-1-1/NA:2006	Eurocod 1: Acţiuni asupra structurilor. Partea 1-1: Acţiuni generale. Greutăţi specifice, greutăţi proprii, încărcări utile pentru clădiri .

	Anexa națională
SR EN 1991-1-2:2004 SR EN 1991-1-1/NA:2006	Eurocod 1: Acţiuni asupra structurilor. Partea 1-2: Acţiuni generale. Acţiuni asupra structurilor expuse la foc . Anexa națională
CR 1-1-3/2012	Cod de proiectare. Evaluarea acţiunii zăpezii asupra construcţiilor
SR EN 1991-1-3:2005 SR EN 1991-1-3/NA:2006	Eurocod 1: Acţiuni asupra structurilor. Partea 1-3: Acţiuni generale. Încărcări date de zăpadă Anexa națională
CR 1-1-4/2012	Cod de proiectare. Evaluarea actiunii vântului asupra constructiilor
SR EN 1991-1-4:2006 SR EN 1991-1-4/NB:2007	Eurocod 1: Acţiuni asupra structurilor. Partea 1-4: Acţiuni generale - Acţiuni ale vântului Anexa națională.
SR EN 1992-1-1:2004 SR EN 1992-1-1/NB:2008	Eurocod 2: Proiectarea structurilor de beton. Partea 1-1: Reguli generale şi reguli pentru clădiri Anexa națională.
SR EN 1992-1-2:2006 SR EN 1992-1-2/NA:2009	Eurocod 2: Proiectarea structurilor de beton. Partea 1-2: Reguli generale. Calculul comportării la foc. Anexa națională
P100-1/2013	Cod de proiectare seismică - Partea I – Prevederi de proiectare pentru clădiri
SR EN 1998-1:2004	Eurocod 8: Proiectarea structurilor pentru rezistenţa la cutremur. Partea 1: Reguli generale, acţiuni seismice şi reguli pentru clădiri
NE 012-1:2007 NE 012-2:2010	Normativ pentru producerea betonului şi executarea lucrărilor din beton, beton armat şi beton precomprimat – Partea 1: Producerea betonului
ST-009-2011	Specificație tehnică privind produse de oțel utilizate ca armături: cerințe și criterii de performanță

INCARCARI PERMANENTE

Element de constructie	Nr. Crt. Strat	Denumire Strat	Grosime strat [m]	Greutate tehnica [kN/m^3]	Incarcarea Caracteristica [daN/m^2]	
Perete exterior neportant	1	Gips-carton + strat de adeziv	0.02	6.65	0.133	
	2	Zidarie din caramida Ytong	0.3	6	1.8	
	3	Mortar adeziv	0.01	21	0.21	
	4	Termoizolatie Polistiren extrudat	0.15	0.2	0.03	2.173
Perete interior gips carton	1	Placa de gips carton	0.025	7.3	0.1825	
	2	Termoizolatie Polistiren extrudat	0.075	0.2	0.015	
	3	Placa de gips carton	0.025	7.3	0.1825	0.38
Planseu curent pardoseala calda	1	Mocheta+strat adeziv	0.01	6	0.06	
	2	Sapa slab armata	0.06	21	1.26	
	3	Folie PE	0.0002	5	0.001	
	4	Fonoizolatie vata minerala	0.05	1	0.05	
	6	Bariera contra vaporilor	0.0004	5	0.002	
	7	Planseu beton armat	0.12	25	3	
	8	Tavan suspendat	0.48		0.65	5.023
Planseu curent pardoseala rece	1	Gresie+strat adeziv	0.018	24	0.43	
	2	Hidroizolatie bituminoasa	0.002		0.12	
	3	Sapa slab armata	0.05	21	1.05	
	4	Folie PE	0.0002	5	0.001	
	5	Fonoizolatie vata minerala	0.05	1	0.05	
	6	Bariera contra vaporilor	0.0004	5	0.002	
	7	Planseu beton armat	0.12	25	3	
	8	Tavan suspendat	0.48		0.65	5.303
	1	Strat de lestare pietris spalat	0.05	18	0.9	
	2	Membrana de hidroizolatie	0.0004		0.18	

Planseu terasa necirculabila	3	Termoizolatie vata minerala	0.18	1	0.18	
	4	Folie PE	0.0002	6	0.0012	
	5	Beton panta	0.09	16	1.44	
	6	Bariera contra vaporilor	0.0004	5	0.002	
	7	Planseu beton armat	0.12	25	3	
	8	Tavan suspendat	0.48		0.65	6.3532
Atic	1	Termoizolatie polistiren extrudat	0.15	0.2	0.03	
	2	Mortar adeziv	0.01	21	0.21	
	3	Atic din beton armat	0.15	25	3.75	
	4	Termoizolatie vata minerala	0.1	1	0.1	
	5	Membrana de hidroizolatie(verticala)	0.0006		0.18	
	6	Str. De protectie hidroizolatie	0.02	19	0.38	4.65

	q		ag		B(0)
	4.725		0.981		2.5
	T	B(T)	Se(T)	Sd(T)	
	0	1	0.981	0.981	
	0.01	1.107143	1.086107	0.948003	
	0.02	1.214286	1.191214	0.915007	
	0.03	1.321429	1.296321	0.88201	
	0.04	1.428571	1.401429	0.849014	
	0.05	1.535714	1.506536	0.816017	
	0.06	1.642857	1.611643	0.78302	
	0.07	1.75	1.71675	0.750024	
	0.08	1.857143	1.821857	0.717027	
	0.09	1.964286	1.926964	0.684031	
	0.1	2.071429	2.032071	0.651034	
	0.11	2.178571	2.137179	0.618037	
	0.12	2.285714	2.242286	0.585041	
	0.13	2.392857	2.347393	0.552044	
T.B	0.14	2.5	2.4525	0.519048	
	0.15	2.5	2.4525	0.519048	
	0.16	2.5	2.4525	0.519048	
	0.17	2.5	2.4525	0.519048	
	0.18	2.5	2.4525	0.519048	
	0.19	2.5	2.4525	0.519048	
	0.2	2.5	2.4525	0.519048	
	0.21	2.5	2.4525	0.519048	
	0.22	2.5	2.4525	0.519048	
	0.23	2.5	2.4525	0.519048	
	0.24	2.5	2.4525	0.519048	
	0.25	2.5	2.4525	0.519048	
	0.26	2.5	2.4525	0.519048	
	0.27	2.5	2.4525	0.519048	
	0.28	2.5	2.4525	0.519048	
	0.29	2.5	2.4525	0.519048	
	0.3	2.5	2.4525	0.519048	
	0.31	2.5	2.4525	0.519048	
	0.32	2.5	2.4525	0.519048	
	0.33	2.5	2.4525	0.519048	
	0.34	2.5	2.4525	0.519048	
	0.35	2.5	2.4525	0.519048	
	0.36	2.5	2.4525	0.519048	
	0.37	2.5	2.4525	0.519048	
	0.38	2.5	2.4525	0.519048	
	0.39	2.5	2.4525	0.519048	
	0.4	2.5	2.4525	0.519048	
	0.41	2.5	2.4525	0.519048	
	0.42	2.5	2.4525	0.519048	
	0.43	2.5	2.4525	0.519048	

	0.44	2.5	2.4525	0.519048
	0.45	2.5	2.4525	0.519048
	0.46	2.5	2.4525	0.519048
	0.47	2.5	2.4525	0.519048
	0.48	2.5	2.4525	0.519048
	0.49	2.5	2.4525	0.519048
	0.5	2.5	2.4525	0.519048
	0.51	2.5	2.4525	0.519048
	0.52	2.5	2.4525	0.519048
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	0.55	2.5	2.4525	0.519048
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	0.57	2.5	2.4525	0.519048
	0.58	2.5	2.4525	0.519048
	0.59	2.5	2.4525	0.519048
	0.6	2.5	2.4525	0.519048
	0.61	2.5	2.4525	0.519048
	0.62	2.5	2.4525	0.519048
	0.63	2.5	2.4525	0.519048
	0.64	2.5	2.4525	0.519048
	0.65	2.5	2.4525	0.519048
	0.66	2.5	2.4525	0.519048
	0.67	2.5	2.4525	0.519048
	0.68	2.5	2.4525	0.519048
	0.69	2.5	2.4525	0.519048
T.C	0.7	2.5	2.4525	0.519048
	0.71	2.464789	2.417958	0.511737
	0.72	2.430556	2.384375	0.50463
	0.73	2.39726	2.351712	0.497717
	0.74	2.364865	2.319932	0.490991
	0.75	2.333333	2.289	0.484444
	0.76	2.302632	2.258882	0.47807
	0.77	2.272727	2.229545	0.471861
	0.78	2.24359	2.200962	0.465812
	0.79	2.21519	2.173101	0.459916
	0.8	2.1875	2.145938	0.454167
	0.81	2.160494	2.119444	0.44856
	0.82	2.134146	2.093598	0.443089
	0.83	2.108434	2.068373	0.437751
	0.84	2.083333	2.04375	0.43254
	0.85	2.058824	2.019706	0.427451
	0.86	2.034884	1.996221	0.422481
	0.87	2.011494	1.973276	0.417625
	0.88	1.988636	1.950852	0.412879
	0.89	1.966292	1.928933	0.40824
	0.9	1.944444	1.9075	0.403704

0.91	1.923077	1.886538	0.399267
0.92	1.902174	1.866033	0.394928
0.93	1.88172	1.845968	0.390681
0.94	1.861702	1.82633	0.386525
0.95	1.842105	1.807105	0.382456
0.96	1.822917	1.788281	0.378472
0.97	1.804124	1.769845	0.37457
0.98	1.785714	1.751786	0.370748
0.99	1.767677	1.734091	0.367003
1	1.75	1.71675	0.363333
1.01	1.732673	1.699752	0.359736
1.02	1.715686	1.683088	0.356209
1.03	1.699029	1.666748	0.352751
1.04	1.682692	1.650721	0.349359
1.05	1.666667	1.635	0.346032
1.06	1.650943	1.619575	0.342767
1.07	1.635514	1.604439	0.339564
1.08	1.62037	1.589583	0.33642
1.09	1.605505	1.575	0.333333
1.1	1.590909	1.560682	0.330303
1.11	1.576577	1.546622	0.327327
1.12	1.5625	1.532813	0.324405
1.13	1.548673	1.519248	0.321534
1.14	1.535088	1.505921	0.318713
1.15	1.521739	1.492826	0.315942
1.16	1.508621	1.479957	0.313218
1.17	1.495726	1.467308	0.310541
1.18	1.483051	1.454873	0.30791
1.19	1.470588	1.442647	0.305322
1.2	1.458333	1.430625	0.302778
1.21	1.446281	1.418802	0.300275
1.22	1.434426	1.407172	0.297814
1.23	1.422764	1.395732	0.295393
1.24	1.41129	1.384476	0.293011
1.25	1.4	1.3734	0.290667
1.26	1.388889	1.3625	0.28836
1.27	1.377953	1.351772	0.286089
1.28	1.367188	1.341211	0.283854
1.29	1.356589	1.330814	0.281654
1.3	1.346154	1.320577	0.279487
1.31	1.335878	1.310496	0.277354
1.32	1.325758	1.300568	0.275253
1.33	1.315789	1.290789	0.273183
1.34	1.30597	1.281157	0.271144
1.35	1.296296	1.271667	0.269136
1.36	1.286765	1.262316	0.267157
1.37	1.277372	1.253102	0.265207

1.38	1.268116	1.244022	0.263285
1.39	1.258993	1.235072	0.261391
1.4	1.25	1.22625	0.259524
1.41	1.241135	1.217553	0.257683
1.42	1.232394	1.208979	0.255869
1.43	1.223776	1.200524	0.254079
1.44	1.215278	1.192188	0.252315
1.45	1.206897	1.183966	0.250575
1.46	1.19863	1.175856	0.248858
1.47	1.190476	1.167857	0.247166
1.48	1.182432	1.159966	0.245495
1.49	1.174497	1.152181	0.243848
1.5	1.166667	1.1445	0.242222
1.51	1.15894	1.136921	0.240618
1.52	1.151316	1.129441	0.239035
1.53	1.143791	1.122059	0.237473
1.54	1.136364	1.114773	0.235931
1.55	1.129032	1.107581	0.234409
1.56	1.121795	1.100481	0.232906
1.57	1.11465	1.093471	0.231423
1.58	1.107595	1.086551	0.229958
1.59	1.100629	1.079717	0.228512
1.6	1.09375	1.072969	0.227083
1.61	1.086957	1.066304	0.225673
1.62	1.080247	1.059722	0.22428
1.63	1.07362	1.053221	0.222904
1.64	1.067073	1.046799	0.221545
1.65	1.060606	1.040455	0.220202
1.66	1.054217	1.034187	0.218876
1.67	1.047904	1.027994	0.217565
1.68	1.041667	1.021875	0.21627
1.69	1.035503	1.015828	0.21499
1.7	1.029412	1.009853	0.213725
1.71	1.023392	1.003947	0.212476
1.72	1.017442	0.99811	0.21124
1.73	1.011561	0.992341	0.210019
1.74	1.005747	0.986638	0.208812
1.75	1	0.981	0.207619
1.76	0.994318	0.975426	0.206439
1.77	0.988701	0.969915	0.205273
1.78	0.983146	0.964466	0.20412
1.79	0.977654	0.959078	0.20298
1.8	0.972222	0.95375	0.201852
1.81	0.966851	0.948481	0.200737
1.82	0.961538	0.943269	0.199634
1.83	0.956284	0.938115	0.198543
1.84	0.951087	0.933016	0.197464

1.85	0.945946	0.927973	0.196396
1.86	0.94086	0.922984	0.195341
1.87	0.935829	0.918048	0.194296
1.88	0.930851	0.913165	0.193262
1.89	0.925926	0.908333	0.19224
1.9	0.921053	0.903553	0.191228
1.91	0.91623	0.898822	0.190227
1.92	0.911458	0.894141	0.189236
1.93	0.906736	0.889508	0.188256
1.94	0.902062	0.884923	0.187285
1.95	0.897436	0.880385	0.186325
1.96	0.892857	0.875893	0.185374
1.97	0.888325	0.871447	0.184433
1.98	0.883838	0.867045	0.183502
1.99	0.879397	0.862688	0.18258
2	0.875	0.858375	0.181667
2.01	0.870647	0.854104	0.180763
2.02	0.866337	0.849876	0.179868
2.03	0.862069	0.84569	0.178982
2.04	0.857843	0.841544	0.178105
2.05	0.853659	0.837439	0.177236
2.06	0.849515	0.833374	0.176375
2.07	0.845411	0.829348	0.175523
2.08	0.841346	0.825361	0.174679
2.09	0.837321	0.821411	0.173844
2.1	0.833333	0.8175	0.173016
2.11	0.829384	0.813626	0.172196
2.12	0.825472	0.809788	0.171384
2.13	0.821596	0.805986	0.170579
2.14	0.817757	0.80222	0.169782
2.15	0.813953	0.798488	0.168992
2.16	0.810185	0.794792	0.16821
2.17	0.806452	0.791129	0.167435
2.18	0.802752	0.7875	0.166667
2.19	0.799087	0.783904	0.165906
2.2	0.795455	0.780341	0.165152
2.21	0.791855	0.77681	0.164404
2.22	0.788288	0.773311	0.163664
2.23	0.784753	0.769843	0.16293
2.24	0.78125	0.766406	0.162202
2.25	0.777778	0.763	0.161481
2.26	0.774336	0.759624	0.160767
2.27	0.770925	0.756278	0.160059
2.28	0.767544	0.752961	0.159357
2.29	0.764192	0.749672	0.158661
2.3	0.76087	0.746413	0.157971
2.31	0.757576	0.743182	0.157287

2.32	0.75431	0.739978	0.156609
2.33	0.751073	0.736803	0.155937
2.34	0.747863	0.733654	0.155271
2.35	0.744681	0.730532	0.15461
2.36	0.741525	0.727436	0.153955
2.37	0.738397	0.724367	0.153305
2.38	0.735294	0.721324	0.152661
2.39	0.732218	0.718305	0.152022
2.4	0.729167	0.715313	0.151389
2.41	0.726141	0.712344	0.150761
2.42	0.72314	0.709401	0.150138
2.43	0.720165	0.706481	0.14952
2.44	0.717213	0.703586	0.148907
2.45	0.714286	0.700714	0.148299
2.46	0.711382	0.697866	0.147696
2.47	0.708502	0.69504	0.147099
2.48	0.705645	0.692238	0.146505
2.49	0.702811	0.689458	0.145917
2.5	0.7	0.6867	0.145333
2.51	0.697211	0.683964	0.144754
2.52	0.694444	0.68125	0.14418
2.53	0.6917	0.678557	0.14361
2.54	0.688976	0.675886	0.143045
2.55	0.686275	0.673235	0.142484
2.56	0.683594	0.670605	0.141927
2.57	0.680934	0.667996	0.141375
2.58	0.678295	0.665407	0.140827
2.59	0.675676	0.662838	0.140283
2.6	0.673077	0.660288	0.139744
2.61	0.670498	0.657759	0.139208
2.62	0.667939	0.655248	0.138677
2.63	0.665399	0.652757	0.13815
2.64	0.662879	0.650284	0.137626
2.65	0.660377	0.64783	0.137107
2.66	0.657895	0.645395	0.136591
2.67	0.655431	0.642978	0.13608
2.68	0.652985	0.640578	0.135572
2.69	0.650558	0.638197	0.135068
2.7	0.648148	0.635833	0.134568
2.71	0.645756	0.633487	0.134071
2.72	0.643382	0.631158	0.133578
2.73	0.641026	0.628846	0.133089
2.74	0.638686	0.626551	0.132603
2.75	0.636364	0.624273	0.132121
2.76	0.634058	0.622011	0.131643
2.77	0.631769	0.619765	0.131167
2.78	0.629496	0.617536	0.130695

	2.79	0.62724	0.615323	0.130227
	2.8	0.625	0.613125	0.129762
	2.81	0.622776	0.610943	0.1293
	2.82	0.620567	0.608777	0.128842
	2.83	0.618375	0.606625	0.128386
	2.84	0.616197	0.604489	0.127934
	2.85	0.614035	0.602368	0.127485
	2.86	0.611888	0.600262	0.12704
	2.87	0.609756	0.598171	0.126597
	2.88	0.607639	0.596094	0.126157
	2.89	0.605536	0.594031	0.125721
	2.9	0.603448	0.591983	0.125287
	2.91	0.601375	0.589948	0.124857
	2.92	0.599315	0.587928	0.124429
	2.93	0.59727	0.585922	0.124005
	2.94	0.595238	0.583929	0.123583
	2.95	0.59322	0.581949	0.123164
	2.96	0.591216	0.579983	0.122748
	2.97	0.589226	0.57803	0.122334
	2.98	0.587248	0.576091	0.121924
	2.99	0.585284	0.574164	0.121516
T.D	3	0.583333	0.57225	0.121111
	3.01	0.579464	0.568454	0.120308
	3.02	0.575633	0.564696	0.119512
	3.03	0.571839	0.560974	0.118725
	3.04	0.568083	0.55729	0.117945
	3.05	0.564364	0.553641	0.117173
	3.06	0.560682	0.550029	0.116408
	3.07	0.557035	0.546451	0.115651
	3.08	0.553424	0.542909	0.114901
	3.09	0.549848	0.539401	0.114159
	3.1	0.546306	0.535926	0.113424
	3.11	0.542798	0.532485	0.112695
	3.12	0.539324	0.529077	0.111974
	3.13	0.535884	0.525702	0.11126
	3.14	0.532476	0.522359	0.110552
	3.15	0.529101	0.519048	0.109851
	3.16	0.525757	0.515768	0.109157
	3.17	0.522445	0.512519	0.10847
	3.18	0.519165	0.5093	0.107788
	3.19	0.515915	0.506112	0.107114
	3.2	0.512695	0.502954	0.106445
	3.21	0.509506	0.499825	0.105783
	3.22	0.506346	0.496726	0.105127
	3.23	0.503216	0.493655	0.104477
	3.24	0.500114	0.490612	0.103833
	3.25	0.497041	0.487598	0.103195

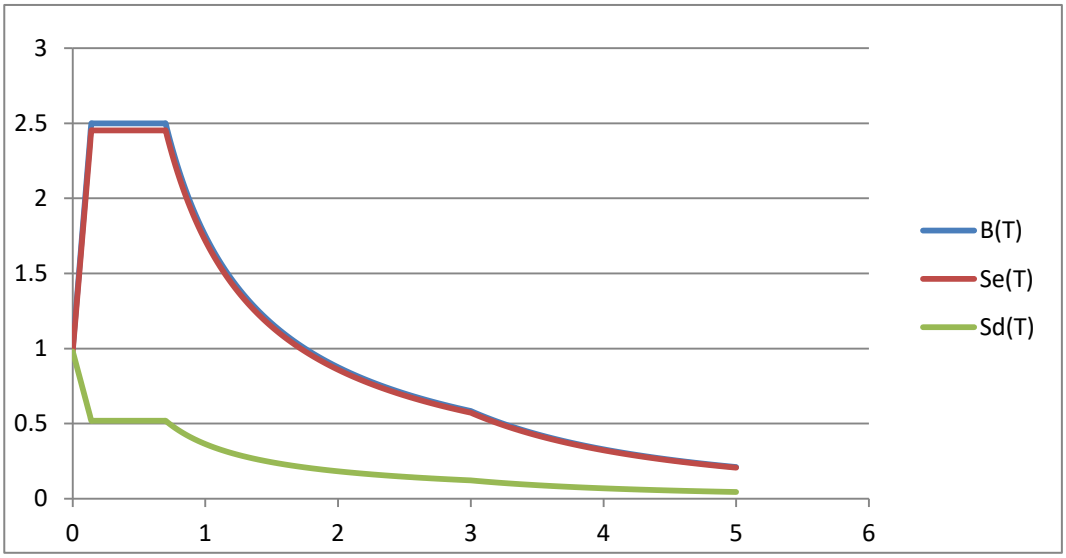
3.26	0.493997	0.484611	0.102563
3.27	0.49098	0.481651	0.101937
3.28	0.487991	0.478719	0.101316
3.29	0.485029	0.475813	0.100701
3.3	0.482094	0.472934	0.100092
3.31	0.479185	0.470081	0.099488
3.32	0.476303	0.467253	0.09889
3.33	0.473446	0.464451	0.098296
3.34	0.470616	0.461674	0.097709
3.35	0.46781	0.458922	0.097126
3.36	0.46503	0.456194	0.096549
3.37	0.462274	0.453491	0.095977
3.38	0.459543	0.450811	0.09541
3.39	0.456836	0.448156	0.094848
3.4	0.454152	0.445523	0.094291
3.41	0.451493	0.442914	0.093738
3.42	0.448856	0.440328	0.093191
3.43	0.446243	0.437764	0.092648
3.44	0.443652	0.435223	0.092111
3.45	0.441084	0.432703	0.091577
3.46	0.438538	0.430206	0.091049
3.47	0.436014	0.42773	0.090525
3.48	0.433512	0.425275	0.090005
3.49	0.431031	0.422841	0.08949
3.5	0.428571	0.420429	0.08898
3.51	0.426133	0.418036	0.088473
3.52	0.423715	0.415665	0.087971
3.53	0.421318	0.413313	0.087474
3.54	0.418941	0.410981	0.08698
3.55	0.416584	0.408669	0.086491
3.56	0.414247	0.406376	0.086006
3.57	0.411929	0.404103	0.085524
3.58	0.409631	0.401848	0.085047
3.59	0.407353	0.399613	0.084574
3.6	0.405093	0.397396	0.084105
3.61	0.402851	0.395197	0.08364
3.62	0.400629	0.393017	0.083178
3.63	0.398425	0.390854	0.082721
3.64	0.396238	0.38871	0.082267
3.65	0.39407	0.386583	0.081816
3.66	0.39192	0.384473	0.08137
3.67	0.389787	0.382381	0.080927
3.68	0.387671	0.380306	0.080488
3.69	0.385573	0.378247	0.080052
3.7	0.383492	0.376205	0.07962
3.71	0.381427	0.37418	0.079192
3.72	0.379379	0.372171	0.078766

3.73	0.377348	0.370178	0.078345
3.74	0.375332	0.368201	0.077926
3.75	0.373333	0.36624	0.077511
3.76	0.37135	0.364295	0.077099
3.77	0.369383	0.362364	0.076691
3.78	0.367431	0.36045	0.076286
3.79	0.365495	0.35855	0.075884
3.8	0.363573	0.356666	0.075485
3.81	0.361667	0.354796	0.075089
3.82	0.359776	0.352941	0.074696
3.83	0.3579	0.3511	0.074307
3.84	0.356038	0.349274	0.07392
3.85	0.354191	0.347462	0.073537
3.86	0.352358	0.345664	0.073156
3.87	0.35054	0.34388	0.072779
3.88	0.348735	0.342109	0.072404
3.89	0.346945	0.340353	0.072032
3.9	0.345168	0.338609	0.071663
3.91	0.343404	0.33688	0.071297
3.92	0.341655	0.335163	0.070934
3.93	0.339918	0.33346	0.070573
3.94	0.338195	0.331769	0.070216
3.95	0.336485	0.330091	0.069861
3.96	0.334787	0.328426	0.069508
3.97	0.333103	0.326774	0.069158
3.98	0.331431	0.325134	0.068811
3.99	0.329772	0.323506	0.068467
4	0.328125	0.321891	0.068125
4.01	0.326491	0.320287	0.067786
4.02	0.324868	0.318696	0.067449
4.03	0.323258	0.317116	0.067115
4.04	0.32166	0.315548	0.066783
4.05	0.320073	0.313992	0.066453
4.06	0.318498	0.312447	0.066126
4.07	0.316935	0.310913	0.065802
4.08	0.315384	0.309391	0.06548
4.09	0.313843	0.30788	0.06516
4.1	0.312314	0.30638	0.064842
4.11	0.310796	0.304891	0.064527
4.12	0.309289	0.303413	0.064214
4.13	0.307793	0.301945	0.063904
4.14	0.306308	0.300488	0.063595
4.15	0.304834	0.299042	0.063289
4.16	0.30337	0.297606	0.062985
4.17	0.301917	0.29618	0.062684
4.18	0.300474	0.294765	0.062384
4.19	0.299041	0.29336	0.062087

4.2	0.297619	0.291964	0.061791
4.21	0.296207	0.290579	0.061498
4.22	0.294805	0.289203	0.061207
4.23	0.293412	0.287838	0.060918
4.24	0.29203	0.286482	0.060631
4.25	0.290657	0.285135	0.060346
4.26	0.289294	0.283798	0.060063
4.27	0.287941	0.28247	0.059782
4.28	0.286597	0.281152	0.059503
4.29	0.285263	0.279843	0.059226
4.3	0.283937	0.278542	0.058951
4.31	0.282621	0.277251	0.058678
4.32	0.281314	0.275969	0.058406
4.33	0.280016	0.274696	0.058137
4.34	0.278728	0.273432	0.057869
4.35	0.277447	0.272176	0.057603
4.36	0.276176	0.270929	0.057339
4.37	0.274914	0.26969	0.057077
4.38	0.27366	0.26846	0.056817
4.39	0.272415	0.267239	0.056558
4.4	0.271178	0.266025	0.056302
4.41	0.269949	0.26482	0.056047
4.42	0.268729	0.263623	0.055793
4.43	0.267517	0.262434	0.055542
4.44	0.266314	0.261254	0.055292
4.45	0.265118	0.260081	0.055044
4.46	0.263931	0.258916	0.054797
4.47	0.262751	0.257759	0.054552
4.48	0.261579	0.256609	0.054309
4.49	0.260415	0.255467	0.054067
4.5	0.259259	0.254333	0.053827
4.51	0.258111	0.253207	0.053589
4.52	0.25697	0.252088	0.053352
4.53	0.255837	0.250976	0.053117
4.54	0.254711	0.249871	0.052883
4.55	0.253593	0.248774	0.052651
4.56	0.252482	0.247684	0.05242
4.57	0.251378	0.246602	0.052191
4.58	0.250281	0.245526	0.051963
4.59	0.249192	0.244457	0.051737
4.6	0.24811	0.243396	0.051512
4.61	0.247034	0.242341	0.051289
4.62	0.245966	0.241293	0.051067
4.63	0.244905	0.240252	0.050847
4.64	0.24385	0.239217	0.050628
4.65	0.242803	0.238189	0.05041
4.66	0.241762	0.237168	0.050194

4.67	0.240727	0.236154	0.04998
4.68	0.2397	0.235145	0.049766
4.69	0.238679	0.234144	0.049554
4.7	0.237664	0.233148	0.049344
4.71	0.236656	0.23216	0.049134
4.72	0.235654	0.231177	0.048926
4.73	0.234659	0.2302	0.04872
4.74	0.23367	0.22923	0.048514
4.75	0.232687	0.228266	0.04831
4.76	0.23171	0.227308	0.048107
4.77	0.23074	0.226356	0.047906
4.78	0.229775	0.22541	0.047706
4.79	0.228817	0.224469	0.047507
4.8	0.227865	0.223535	0.047309
4.81	0.226918	0.222607	0.047113
4.82	0.225978	0.221684	0.046917
4.83	0.225043	0.220767	0.046723
4.84	0.224114	0.219856	0.04653
4.85	0.223191	0.21895	0.046339
4.86	0.222273	0.21805	0.046148
4.87	0.221361	0.217155	0.045959
4.88	0.220455	0.216266	0.045771
4.89	0.219554	0.215383	0.045584
4.9	0.218659	0.214504	0.045398
4.91	0.217769	0.213632	0.045213
4.92	0.216885	0.212764	0.045029
4.93	0.216006	0.211902	0.044847
4.94	0.215132	0.211045	0.044666
4.95	0.214264	0.210193	0.044485
4.96	0.213401	0.209346	0.044306
4.97	0.212543	0.208505	0.044128
4.98	0.21169	0.207668	0.043951
4.99	0.210843	0.206837	0.043775
5	0.21	0.20601	0.0436

SPECTRUL DE PROIECTARE



Ciobota Sergiu- Alexandru
An IV, grupa 32401

Construcții din Beton Armat II
Proiect

n=25
Localitate: Cluj- Napoca

$n := 25$ $q_n := 2.55\ \frac{kN}{m^2}$

$l_1 := 5.05\ m$

$l_2 := 5.6\ m$ $h_{parter} := 4\ m$ inaltimea utila a parterului

$t_1 := 4.55\ m$

$t_2 := 3.75\ m$ $h_{etaj} := 3.2\ m$ inaltimea utila la etaje

Predimensionare

Predimensionarea placii de b.a

$l_{max} := l_2 = 5.6\ m$ $l_{min} := t_2 = 3.75\ m$

$\frac{l_{max}}{l_{min}} = 1.493$ $1.493 \leq 2$ => armare pe 2 directii

$l_{min} := t_1 = 4.55\ m$ -cea mai mica latura de pe ochiul de placa cel mai

$h_{p.min.1} := \frac{l_{min}}{40} = 113.75\ mm$ rezemare pe tot conturul (cazul mai defavorabil)

-cond de rigiditate

$h_{p.min.1.2} := \frac{l_{min}}{45} = 101.111\ mm$ incastare pe 4 laturi (cazul mai real)

$h_{p.min.2} := 50\ mm$ -cond de grosime minimă

$h_{p.min.3} := 80\ mm$ -cond de diafragmă orizontală

$h_{p.min.4} := 80\ mm$ -cond de rezistență la foc

$h_{p.min} := \max\left(h_{p.min.1}, h_{p.min.1.2}, h_{p.min.2}, h_{p.min.3}, h_{p.min.4}\right) = 113.75\ mm$

aleg $h_p := 12\ cm$

Predimensionarea grinzilor

-grinzi longitudinale:

$l := \max(l_1, l_2) = 5.6\ m$

$h_{gl} = \left(\frac{l}{8} .. \frac{l}{12}\right)$ $\frac{l}{8} = 0.7\ m$ $\frac{l}{12} = 0.467\ m$ aleg $h_{gl} := 60\ cm$ $b_{gl} := 30\ cm$

-grinzi trasnversale:

$l := \max(t_1, t_2) = 4.55\ m$

$h_{gl} = \left(\frac{l}{8} .. \frac{l}{12}\right)$ $\frac{l}{8} = 0.569\ m$ $\frac{l}{12} = 0.379\ m$ aleg $h_{gt} := 50\ cm$ $b_{gt} := 30\ cm$

Evaluarea incarcarilor

Incarcari permanente

-planseu pardoseala rece

$g_{k.pr} := 5.303\ \frac{kN}{m^2}$

-planseu terasa necirculabila

$g_{k.pt} := 6.35\ \frac{kN}{m^2}$

-perete exterior din zidarie neportanta

$g_{k.p.ext} := 2.2\ \frac{kN}{m^2}$

-etaj curent: Inaltimea peretilor pe plan longitudinal

$g_{k.p.ext.l} := g_{k.p.ext} \cdot (h_{etaj} + 84\ cm - h_{gl}) = 7.568\ \frac{kN}{m}$

-etaj curent: Inaltimea peretilor pe plan trasnversal

$g_{k.p.ext.t} := g_{k.p.ext} \cdot (h_{etaj} + 84\ cm - h_{gt}) = 7.788\ \frac{kN}{m}$

-parter: Inaltimea peretilor pe plan longitudinal

$g_{k.p.ext.l.p} := g_{k.p.ext} \cdot (h_{parter} + 84\ cm - h_{gl}) = 9.328\ \frac{kN}{m}$

-parter: Inaltimea peretilor pe plan trasnversal

$g_{k.p.ext.t.p} := g_{k.p.ext} \cdot (h_{parter} + 84\ cm - h_{gt}) = 9.548\ \frac{kN}{m}$

- atic -h atic=0.8m

$g_a := 4.69\ \frac{kN}{m^2}$ $g_{k.a} := 4.69\ \frac{kN}{m^2} \cdot 0.8\ m = 3.752\ \frac{kN}{m}$

Incarcari utile

$q_n = 2.55\ \frac{kN}{m^2}$ din tema de proiect

$G_{perete.desp} := 0.38\ \frac{kN}{m^2}$ $G_{perete.ml} := G_{perete.desp} \cdot h_{etaj} = 1.216\ \frac{kN}{m}$

$G_{perete.ml} \le 2\ \frac{kN}{m}$ => $q_{k.pd} := 0.8\ \frac{kN}{m^2}$ $q_{k.total} := q_n + q_{k.pd} = 3.35\ \frac{kN}{m^2}$

Incarcarea din zapada

$\gamma_{Is} := 1.15$ $\mu_i := 0.8$ $C_e := 1$ $C_t := 1$ $s_k := 1.5\ \frac{kN}{m^2}$

$S := \gamma_{Is} \cdot \mu_i \cdot C_e \cdot C_t \cdot s_k = 1.38\ \frac{kN}{m^2}$

Incarcarea din vant

$q_b := 0.5\ kPa$ -Pentru Cluj-Napoca

CTA=-0.20m $h_{atic} := 0.8\ m$

$H_{cladire} := 20\ cm + (h_{etaj} + 84\ cm) \cdot 4 + h_{parter} + 84\ cm + h_{atic} = 22\ m$

Vant pe directia longitudinala

$b_{cladire.l} := 2 \cdot t_1 + t_2 + b_{gl} = 13.15\ m$ *latura perpendiculara pe dir. vantului*

$d_{cladire.l} := 2 \cdot l_1 + 2 \cdot l_2 + b_{gt} = 21.6\ m$ *latura paralela cu dir. vantului*

$\text{if}\left(b_{cladire.l} < H_{cladire} < b_{cladire.l} \cdot 2, \text{“două zone”}, \text{“o zonă”}\right) = \text{“două zone”}$

$e := min\left(b_{cladire.l}, 2 \cdot H_{cladire}\right) = 13.15\ m$

$\text{if}\left(e \le d_{cladire.l}, \text{“zone A,B,C”}, \text{“zone A,B”}\right) = \text{“zone A,B,C”}$

a) presiunea/ suctiunea vantului la inaltimea de referinta z=b

$z_e := b_{cladire.l} = 13.15\ m$

-viteza de referinta a vantului

$v_b := \sqrt{1.6 \cdot 0.5} = 0.894$ $v_b := 0.894\ \frac{m}{s}$

categoria de teren IV => $z_0 := 1\ m$ $z_{min} := 10\ m$ $\beta := 2.12^2$

-viteza medie a vantului

$$k_r := 0.189 \cdot \left(\frac{z_0}{0.05\ m}\right)^{0.07} = 0.233$$

$$c_r z := k_r \cdot \ln\left(\frac{z_e}{z_0}\right) = 0.601$$

$$v_m z := c_r z \cdot v_b = 0.537\ \frac{m}{s}$$

-turbulenta vantului la inaltimea z

$$I_v z := \frac{\sqrt{\beta}}{2.5 \ln\left(\frac{z_e}{z_0}\right)} = 0.329$$

$$c_{pq} z := 1 + 7 \cdot I_v z = 3.304$$

$$c_e z := c_{pq} z \cdot c_r z^2 = 1.192$$

$$q_p z := c_e z \cdot q_b = 0.596\ kPa$$

-coeficientii aerodinamici de presiune/sucțiune exterioare

$$\frac{H_{cladire}}{d_{cladire.l}} = 1.019$$

zona A $c_{pe.z.A} := -1.2$
zona B $c_{pe.z.B} := -0.8$
zona C $c_{pe.z.C} := -0.5$
zona D $c_{pe.z.D} := 0.8$
zona E $c_{pe.z.E} := -0.505$

- presiunea/suctiunea vantului la inaltimea de referinta z=b

$\gamma_{Iw} := 1.15$ pentru clasa de importanta II

zona A $w_{e.A.l.1} := \gamma_{Iw} \cdot c_{pe.z.A} \cdot q_p z = -0.822\ kPa$
zona B $w_{e.B.l.1} := \gamma_{Iw} \cdot c_{pe.z.B} \cdot q_p z = -0.548\ kPa$
zona C $w_{e.C.l.1} := \gamma_{Iw} \cdot c_{pe.z.C} \cdot q_p z = -0.343\ kPa$
zona D $w_{e.D.l.1} := \gamma_{Iw} \cdot c_{pe.z.D} \cdot q_p z = 0.548\ kPa$
zona E $w_{e.E.l.1} := \gamma_{Iw} \cdot c_{pe.z.E} \cdot q_p z = -0.346\ kPa$

Calculul presiunilor pe suprafete

grinzi peste parter

$$P_1 := w_{e.D.l.1} \cdot \left(\frac{(h_{parter} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.434\ \frac{kN}{m}$$

grinzi peste et1

$$P_2 := w_{e.D.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.215\ \frac{kN}{m}$$

Calculul suctiunilor pe suprafete

grinzi peste parter

$$P_1 := w_{e.E.l.1} \cdot \left(\frac{(h_{parter} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -1.536\ \frac{kN}{m}$$

grinzi peste et1

$$P_2 := w_{e.E.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -1.398\ \frac{kN}{m}$$

b) presiunea/ sucțiunea vantului la inaltimea de referinta z=h

$$z_e := H_{cladire} = 22\ m$$

-viteza de referinta a vantului

$$v_b := \sqrt{1.6 \cdot 0.5} = 0.894 \qquad v_b := 0.894\ \frac{m}{s}$$

categoria de teren IV => $z_0 := 1\ m$ $z_{min} := 10\ m$ $\beta := 2.12^2$

-viteza medie a vantului

$$k_r := 0.189 \cdot \left(\frac{z_0}{0.05\ m} \right)^{0.07} = 0.233$$

$$c_r z := k_r \cdot \ln\left(\frac{z_e}{z_0} \right) = 0.721$$

$$v_m z := c_r z \cdot v_b = 0.644\ \frac{m}{s}$$

-turbulenta vantului

$$I_v z := \frac{\sqrt{\beta}}{2.5\ \ln\left(\frac{z_e}{z_0} \right)} = 0.274$$

$$c_{pq} z := 1 + 7 \cdot I_v z = 2.92$$

$$c_e z := c_{pq} z \cdot c_r z^2 = 1.516$$

$$q_p z := c_e z \cdot q_b = 0.758\ kPa$$

-coeficientii aerodinamici de presiune/suctiune exterioare

$$\frac{H_{cladire}}{d_{cladire.l}} = 1.019$$

zona A $c_{pe.z.A} := -1.2$
zona B $c_{pe.z.B} := -0.8$
zona C $c_{pe.z.C} := -0.5$
zona D $c_{pe.z.D} := 0.8$
zona E $c_{pe.z.E} := -0.505$

- presiunea/suctiunea vantului la inaltimea de referinta z=H

$\gamma_{Iw} := 1.15$ pentru clasa de importanta II

zona A $w_{e.A.l.2} := \gamma_{Iw} \cdot c_{pe.z.A} \cdot q_p z = -1.046\ kPa$
zona B $w_{e.B.l.2} := \gamma_{Iw} \cdot c_{pe.z.B} \cdot q_p z = -0.697\ kPa$
zona C $w_{e.C.l.2} := \gamma_{Iw} \cdot c_{pe.z.C} \cdot q_p z = -0.436\ kPa$
zona D $w_{e.D.l.2} := \gamma_{Iw} \cdot c_{pe.z.D} \cdot q_p z = 0.697\ kPa$
zona E $w_{e.E.l.2} := \gamma_{Iw} \cdot c_{pe.z.E} \cdot q_p z = -0.44\ kPa$

Calculul presiunilor pe suprafete

grinzi peste et2

$$P_2 := w_{e.D.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} \right) + w_{e.D.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.516\ \frac{kN}{m}$$

grinzi peste et3

$$P_3 := w_{e.D.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.817\ \frac{kN}{m}$$

grinzi peste et4

$$P_3 := w_{e.D.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.817\ \frac{kN}{m}$$

Calculul suctiunilor pe suprafete

grinzi peste et2

$$P_2 := w_{e.E.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} \right) + w_{e.E.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} \right) = -1.588\ \frac{kN}{m}$$

grinzi peste et3

$$P_3 := w_{e.E.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -1.779\ \frac{kN}{m}$$

grinzi peste et4

$$P_3 := w_{e.E.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -1.779\ \frac{kN}{m}$$

Vant pe direcție transversala

$b_{cladire.t} := 2 \cdot l_1 + 2 \cdot l_2 + b_{gl} = 21.6\ m$ *latura perpendiculara pe dir. vantului*

$d_{cladire.t} := 2 \cdot t_1 + t_2 + b_{gl} = 13.15\ m$ *latura paralela cu dir. vantului*

$\text{if}\left(b_{cladire.l} < H_{cladire} < b_{cladire.l} \cdot 2, \text{“două zone”}, \text{“o zonă”}\right) = \text{“două zone”}$

$e := min\left(b_{cladire.l}, 2 \cdot H_{cladire}\right) = 13.15\ m$ $H_{cladire} = 22\ m$

$\text{if}\left(e \le d_{cladire.l}, \text{“zone A,B,C”}, \text{“zone A,B”}\right) = \text{“zone A,B,C”}$

a) presiunea/ sucțiunea vantului la inaltimea de referinta z=b

$z_e := b_{cladire.t} = 21.6\ m$

-viteza de referinta a vantului

$v_b := \sqrt{1.6 \cdot 0.5} = 0.894$ $v_b := 0.894\ \frac{m}{s}$

categoria de teren IV => $z_0 := 1\ m$ $z_{min} := 10\ m$

-viteza medie a vantului

$$k_r := 0.189 \cdot \left(\frac{z_0}{0.05\ m} \right)^{0.07} = 0.233$$

$$c_r z := k_r \cdot \ln\left(\frac{z_e}{z_0} \right) = 0.716$$

$$v_m z := c_r z \cdot v_b = 0.64\ \frac{m}{s}$$

-turbulenta vantului $I_v z := \frac{\sqrt{\beta}}{2.5 \ln\left(\frac{z_e}{z_0} \right)} = 0.276$

$c_{pq} z := 1 + 7 \cdot I_v z = 2.932$

$$c_e z := c_{pq} z \cdot c_r z^2 = 1.504$$

$$q_p z := c_e z \cdot q_b = 0.752\ kPa$$

-coeficientii aerodinamici de presiune/suctiune exterioare

$$\frac{H_{cladire}}{d_{cladire.t}} = 1.673$$

zona A $c_{pe.z.A} := -1.2$
zona B $c_{pe.z.B} := -0.8$
zona C $c_{pe.z.C} := -0.5$
zona D $c_{pe.z.D} := 0.8$
zona E $c_{pe.z.E} := -0.6$

- presiunea/suctiunea vantului la inaltimea de referinta z=b

$\gamma_{Iw} := 1.15$ pentru clasa de importanță II

zona A $w_{e.A.l.1} := \gamma_{Iw} \cdot c_{pe.z.A} \cdot q_p z = -1.038\ kPa$
zona B $w_{e.B.l.1} := \gamma_{Iw} \cdot c_{pe.z.B} \cdot q_p z = -0.692\ kPa$
zona C $w_{e.C.l.1} := \gamma_{Iw} \cdot c_{pe.z.C} \cdot q_p z = -0.432\ kPa$
zona D $w_{e.D.l.1} := \gamma_{Iw} \cdot c_{pe.z.D} \cdot q_p z = 0.692\ kPa$
zona E $w_{e.E.l.1} := \gamma_{Iw} \cdot c_{pe.z.E} \cdot q_p z = -0.519\ kPa$

<u>Calculul presiunilor pe suprafete</u>
grinzi peste parter

$$P_1 := w_{e.D.l.1} \cdot \left(\frac{(h_{parter} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 3.072\ \frac{kN}{m}$$

grinzi peste et1

$$P_2 := w_{e.D.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.795\ \frac{kN}{m}$$

grinzi peste et2

$$P_2 := w_{e.D.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.795\ \frac{kN}{m}$$

grinzi peste et3

$$P_3 := w_{e.D.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.795\ \frac{kN}{m}$$

<u>Calculul suctiunilor pe suprafete</u>
grinzi peste parter

$$P_1 := w_{e.E.l.1} \cdot \left(\frac{(h_{parter} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -2.304\ \frac{kN}{m}$$

grinzi peste et1

$$P_2 := w_{e.E.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -2.096\ \frac{kN}{m}$$

grinzi peste et2

$$P_2 := w_{e.E.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -2.096\ \frac{kN}{m}$$

grinzi peste et3

$$P_3 := w_{e.E.l.1} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -2.096\ \frac{kN}{m}$$

b) presiunea/ suctiunea vantului la inaltimea de referinta z=h

$$z_e := H_{cladire} = 22\ m$$

-viteza de referinta a vantului

$$v_b := \sqrt{1.6 \cdot 0.5} = 0.894 \qquad v_b := 0.894\ \frac{m}{s}$$

categoria de teren IV => $z_0 := 1\ m$ $z_{min} := 10\ m$

-viteza medie a vantului

$$k_r := 0.189 \cdot \left(\frac{z_0}{0.05\ m} \right)^{0.07} = 0.233$$

$$c_r z := k_r \cdot \ln\left(\frac{z_e}{z_0} \right) = 0.721$$

$$v_m z := c_r z \cdot v_b = 0.644\ \frac{m}{s}$$

-turbulenta vantului

$$I_v z := \frac{\sqrt{\beta}}{2.5\ \ln\left(\frac{z_e}{z_0} \right)} = 0.274$$

$$c_{pq} z := 1 + 7 \cdot I_v z = 2.92$$

$$c_e z := c_{pq} z \cdot c_r z^2 = 1.516$$

$$q_p z := c_e z \cdot q_b = 0.758\ kPa$$

-coeficientii aerodinamici de presiune/suctiune exterioare

$$\frac{H_{cladire}}{d_{cladire.t}} = 1.673$$

zona A $c_{pe.z.A} := -1.2$
zona B $c_{pe.z.B} := -0.8$
zona C $c_{pe.z.C} := -0.5$
zona D $c_{pe.z.D} := 0.8$
zona E $c_{pe.z.E} := -0.6$

- presiunea/sucțiunea vantului la înalțimea de referinta z=H

$\gamma_{Iw} := 1.15$ pentru clasa de importanta II

zona A $w_{e.A.l.2} := \gamma_{Iw} \cdot c_{pe.z.A} \cdot q_p z = -1.046\ kPa$
zona B $w_{e.B.l.2} := \gamma_{Iw} \cdot c_{pe.z.B} \cdot q_p z = -0.697\ kPa$
zona C $w_{e.C.l.2} := \gamma_{Iw} \cdot c_{pe.z.C} \cdot q_p z = -0.436\ kPa$
zona D $w_{e.D.l.2} := \gamma_{Iw} \cdot c_{pe.z.D} \cdot q_p z = 0.697\ kPa$
zona E $w_{e.E.l.2} := \gamma_{Iw} \cdot c_{pe.z.E} \cdot q_p z = -0.523\ kPa$

Calculul mediei presiunii/suctiunii vantului la ultimul etaj

$$w_{e.D.l.2} := \frac{w_{e.D.l.2} \cdot 0.4\ m + w_{e.D.l.1} \cdot 5.24\ m}{5.64\ m} = 0.692\ kPa$$

$$w_{e.E.l.2} := \frac{w_{e.E.l.2} \cdot 0.4\ m + w_{e.E.l.1} \cdot 5.24\ m}{5.64\ m} = -0.519\ kPa$$

Caluclul presiunii
grinzi peste et4

$$P_4 := w_{e.D.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = 2.797\ \frac{kN}{m}$$

Caluclul suctiunii
grinzi peste et4

$$P_4 := w_{e.E.l.2} \cdot \left(\frac{(h_{etaj} + 84\ cm)}{2} + \frac{(h_{etaj} + 84\ cm)}{2} \right) = -2.097\ \frac{kN}{m}$$

Predimensionarea stalpilor -stalp interior 45x45

$H_{parter} := h_{parter} + 84\ cm = 4.84\ m$ $H_{etaj} := h_{etaj} + 84\ cm = 4.04\ m$ $\gamma_{bet} := 25\ \frac{kN}{m^3}$

Voi calcula forta axiala de grupare seismica pentru un stalp central

$N_{G.pt} := \left(\frac{t_1 \cdot l_1}{4} + \frac{t_2 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4} + \frac{t_2 \cdot l_1}{4}\right) \cdot g_{k.pt} = 140.327\ kN$ planseu terasa

$N_{G.pl} := \left(\frac{t_1 \cdot l_1}{4} + \frac{t_2 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4} + \frac{t_2 \cdot l_1}{4}\right) \cdot g_{k.pr} = 117.19\ kN$ planseu- pardoseala rece

$N_{Q.u} := \left(\frac{t_1 \cdot l_1}{4} + \frac{t_2 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4} + \frac{t_2 \cdot l_1}{4}\right) \cdot q_n = 56.352\ kN$ utile (din tema)

$N_{Q.pd} := \left(\frac{t_1 \cdot l_1}{4} + \frac{t_2 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4} + \frac{t_2 \cdot l_1}{4}\right) \cdot q_{k.pd} = 17.679\ kN$ pereti despartitori

$N_{Q.zap} := \left(\frac{t_1 \cdot l_1}{4} + \frac{t_2 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4} + \frac{t_2 \cdot l_1}{4}\right) \cdot S = 30.496\ kN$ din zapada

$N_{G.gr} := \left(h_{gl} \cdot b_{gl} \cdot \frac{l_1}{2} + h_{gl} \cdot b_{gl} \cdot \frac{l_2}{2} + h_{gt} \cdot b_{gt} \cdot \frac{t_1}{2} + h_{gt} \cdot b_{gt} \cdot \frac{t_2}{2}\right) \cdot \gamma_{bet} = 39.525\ kN$ grinzi

$b_{st} := 45\ cm$ $h_{st} := 45\ cm$

$N_{G.gr.pr} := \left(H_{parter} \cdot b_{st} \cdot h_{st} + H_{etaj} \cdot b_{st} \cdot h_{st} \cdot 4\right) \cdot \gamma_{bet} = 106.313\ kN$ gr.pr stalp

$N_{total} := N_{G.pt} + N_{G.pl} \cdot 4 + N_{G.gr.pr} + N_{G.gr} \cdot 5 + 0.3 \cdot 4 \cdot \left(N_{Q.u} + N_{Q.pd}\right) + 0.4 \cdot N_{Q.zap} = \left(1.014 \cdot 10^3\right)\ kN$

Cluj-Napoca=> ag=0.1g => aleg DCM

aleg beton C20/25 $f_{ck} := 20\ MPa$ $f_{cd} := \frac{f_{ck}}{1.5} = 13.333\ MPa$

$A_{st} := b_{st} \cdot h_{st} = 0.203\ m^2$ $\nu_d := 0.5$

$\frac{N_{total}}{A_{st} \cdot f_{cd}} = 0.376$

$\text{if}\left(\frac{N_{total}}{A_{st} \cdot f_{cd}} \le \nu_d, \text{“e bine”}, \text{“nu e bine”}\right) = \text{“e bine”}$

3. Predimensionarea stalpilor -stalp exterior 45x45

$H_{parter} := h_{parter} + 84\ cm = 4.84\ m$ $H_{etaj} := h_{etaj} + 84\ cm = 4.04\ m$ $\gamma_{bet} := 25\ \frac{kN}{m^3}$

Voi calcula forta axiala de grupare seismica pentru un stalp marginal

$N_{G.pl} := \left(\frac{t_1 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4}\right) \cdot g_{k.pr} = 67.56\ kN$ planseu- pardoseala rece

$N_{G.pt} := \left(\frac{t_1 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4}\right) \cdot g_{k.pt} = 80.899\ kN$ planseu terasa

$N_{Q.u} := \left(\frac{t_1 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4}\right) \cdot q_n = 32.487\ kN$ utile (din tema)

$N_{Q.pd} := \left(\frac{t_1 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4}\right) \cdot q_{k.pd} = 10.192\ kN$ pereti despartitori

$N_{Q.zap} := \left(\frac{t_1 \cdot l_2}{4} + \frac{t_1 \cdot l_2}{4}\right) \cdot S = 17.581\ kN$ din zapada

$N_{G.gr} := \left(h_{gl} \cdot b_{gl} \cdot \frac{l_2}{2} + h_{gl} \cdot b_{gl} \cdot \frac{l_2}{2} + h_{gt} \cdot b_{gt} \cdot \frac{t_1}{2}\right) \cdot \gamma_{bet} = 33.731\ kN$ grinzi

$b_{st.m} := 45\ cm$ $h_{st.m} := 45\ cm$

$N_{G.gr.pr} := \left(H_{parter} \cdot b_{st} \cdot h_{st} + H_{etaj} \cdot b_{st.m} \cdot h_{st.m} \cdot 4\right) \cdot \gamma_{bet} = 106.313\ kN$ gr.pr stalp

$N_{total} := N_{G.pt} + N_{G.pt} \cdot 4 + N_{G.gr.pr} + N_{G.gr} \cdot 5 + 0.3 \cdot 4 \cdot \left(N_{Q.u} + N_{Q.pd}\right) + 0.4 \cdot N_{Q.zap} = 684.356\ kN$

Cluj-Napoca=> ag=0.1g => aleg DCM

aleg beton C20/25 $f_{ck} := 20\ MPa$ $f_{cd} := \frac{f_{ck}}{1.5} = 13.333\ MPa$

$A_{st} := b_{st.m} \cdot h_{st.m} = 0.203\ m^2$ $\nu_d := 0.5$

$\frac{N_{total}}{A_{st} \cdot f_{cd}} = 0.253$

$\text{if}\left(\frac{N_{total}}{A_{st} \cdot f_{cd}} \le \nu_d, \text{“e bine”}, \text{“nu e bine”}\right) = \text{“e bine”}$

4. Evaluarea acțiunii seismice

$C_t := 0.075$

$H := H_{cladire} + 0.35\ m = 22.35\ m$ *inaltimea cladirii de la nivelul fundatiei*

$$T_1 := C_t \cdot \left(\frac{H}{m}\right)^{\frac{3}{4}}\ s = 0.771\ s \qquad T_1 := 1.474224\ s$$

Cluj- Napoca=> $T_c := 0.7\ s$ => $T_B := 0.14\ s$ $\beta_0 := 2.5$

$T_D \geq T_1 \geq T_C$ => $\beta_{T1} := \beta_0 \cdot \frac{T_c}{T_1} = 1.187$

$q := 1.35 \cdot 3.5 = 4.725$ cladiri cu mai multe deschideri => $\frac{\alpha_u}{\alpha_1}$ =1.35

$S_d T_1 := 0.1 \cdot g \cdot \frac{\beta_{T1}}{q} = 0.246\ \frac{m}{s^2}$

$\lambda := 1$ $\gamma_{I.e} := 1.2$

Masa structurii

$m_{pl} := (2 \cdot l_1 + 2 \cdot l_2) \cdot (2 \cdot t_1 + t_2) \cdot g_{k.pr} \cdot 4 - (t_1 \cdot l_2) \cdot g_{k.pr} \cdot 4 = (5.265 \cdot 10^3)\ kN$

$m_{pt} := (2 \cdot l_1 + 2 \cdot l_2) \cdot (2 \cdot t_1 + t_2) \cdot g_{k.pt} = (1.738 \cdot 10^3)\ kN$

$m_{st} := (b_{st} \cdot h_{st} \cdot \gamma_{bet} \cdot 6 + b_{st.m} \cdot h_{st.m} \cdot \gamma_{bet} \cdot 14) \cdot (H_{parter} + 4 \cdot H_{etaj}) = (2.126 \cdot 10^3)\ kN$

$m_{scara} := 15.5\ \frac{kN}{m} \cdot 2.8\ m \cdot 2 \cdot 4 = 347.2\ kN$

$$m_{p.ext} := 2 \cdot \begin{pmatrix} (2 \cdot t_1 + t_2)\ g_{k.p.ext.t} \cdot 3 + (2 \cdot t_1 + t_2)\ g_{k.p.ext.t.p} \\ + (2 \cdot l_1 + 2 \cdot l_2)\ g_{k.p.ext.l} \cdot 3 + (2 \cdot l_1 + 2 \cdot l_2)\ g_{k.p.ext.l.p} \end{pmatrix} = (2.21 \cdot 10^3)\ kN$$

$m_{atic} := (2\ t_1 + t_2)\ g_{k.a} + (2\ l_1 + 2\ l_2) \cdot g_{k.a} = 128.131\ kN$

$m_{gr} := (h_{gl} \cdot b_{gl} \cdot (2\ l_1 + 2\ l_2) \cdot 4 + h_{gt} \cdot b_{gt} \cdot (2\ t_1 + t_2) \cdot 5) \cdot \gamma_{bet} \cdot 5 = (3.122 \cdot 10^3)\ kN$

$m_{utile} := (2 \cdot l_1 + 2 \cdot l_2) \cdot (2 \cdot t_1 + t_2) \cdot q_n \cdot 4 - (t_1 \cdot l_2) \cdot q_n \cdot 4 = (2.532 \cdot 10^3)\ kN$

$m_{pd} := (2 \cdot l_1 + 2 \cdot l_2) \cdot (2 \cdot t_1 + t_2) \cdot q_{k.pd} \cdot 4 - (t_1 \cdot l_2) \cdot q_{k.pd} \cdot 4 = 794.32\ kN$

$m_{zap} := (2 \cdot l_1 + 2 \cdot l_2) \cdot (2 \cdot t_1 + t_2) \cdot S = 377.713\ kN$

$M := m_{pl} + m_{pt} + m_{st} + m_{p.ext} + m_{atic} + m_{gr} + m_{scara} + (m_{utile} + m_{pd}) \cdot 0.3 + m_{zap} \cdot 0.4 = 16085.995\ kN$

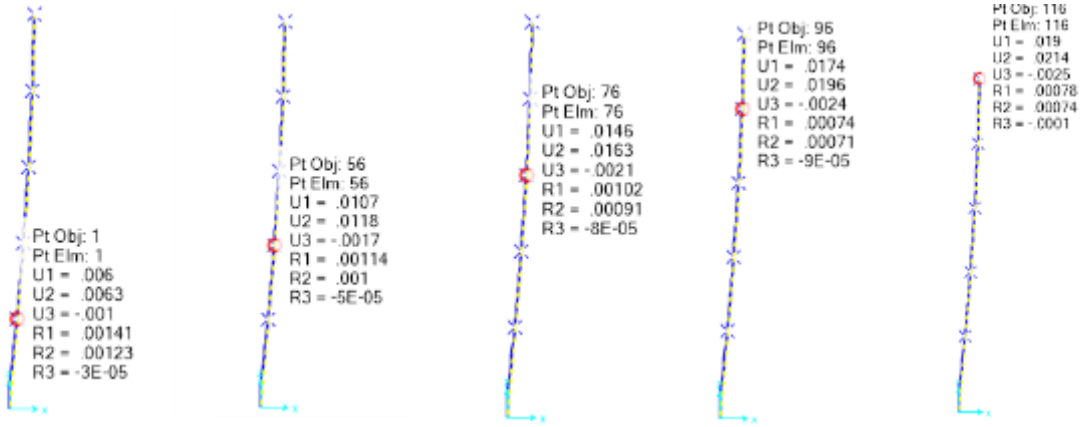
$M := \frac{M}{g} = (1.64 \cdot 10^6)\ kg$

Calculul forței tăietoare de bază

$F_b := \gamma_{I.e} \cdot S_d T_1 \cdot M \cdot \lambda = 484.956\ kN$

INFASURAT...	Combination	Max	471.062	440.718	16211.681	109313.5136	-166184.897	5583.9579
INFASURAT...	Combination	Min	-471.062	-440.718	16211.433	96553.1262	-179803.377	-5583.9579
MODAL	Mode	1	1.474224	0.67832287...	4.26202829...	18.1648851...		

Deplasarile de nivel din Gruparea Seismica:



3. Verificare la deplasari laterale din GS-xy

- la SLS - $EI_c = 0.5\ EI_{brut}$

$\nu := 0.5$
$q = 4.725$

$d.r.e_{5x} := 0.019\ m$ $d.r.e_{5y} := 0.0214\ m$
$d.r.e_{4x} := 0.0174\ m$ $d.r.e_{4y} := 0.0196\ m$
$d.r.e_{3x} := 0.0146\ m$ $d.r.e_{3y} := 0.0163\ m$
$d.r.e_{2x} := 0.0107\ m$ $d.r.e_{2y} := 0.0118\ m$
$d.r.e_{1x} := 0.006\ m$ $d.r.e_{1y} := 0.0063\ m$

$d.r.e_{x5.4} := d.r.e_{5x} - d.r.e_{4x} = 0.002\ m$ $d.r.e_{y5.4} := d.r.e_{5y} - d.r.e_{4y} = 0.002\ m$

$d.r.e_{x4.3} := d.r.e_{4x} - d.r.e_{3x} = 0.003\ m$ $d.r.e_{y4.3} := d.r.e_{4y} - d.r.e_{3y} = 0.003\ m$

$d.r.e_{x3.2} := d.r.e_{3x} - d.r.e_{2x} = 0.004\ m$ $d.r.e_{y3.2} := d.r.e_{3y} - d.r.e_{2y} = 0.005\ m$

$d.r.e_{x2.1} := d.r.e_{2x} - d.r.e_{1x} = 0.005\ m$ $d.r.e_{y2.1} := d.r.e_{2y} - d.r.e_{1y} = 0.006\ m$

$d.r_{SLS5.4x} := d.r.e_{x5.4} \cdot \nu \cdot q = 0.004\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS4.3x} := d.r.e_{x4.3} \cdot \nu \cdot q = 0.007\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS3.2x} := d.r.e_{x3.2} \cdot \nu \cdot q = 0.009\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS2.1x} := d.r.e_{x2.1} \cdot \nu \cdot q = 0.011\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS1x} := d.r.e_{1x} \cdot \nu \cdot q = 0.014\ m < 0.005 \cdot H_{parter} = 0.024\ m$

$d.r_{SLS5.4y} := d.r.e_{y5.4} \cdot \nu \cdot q = 0.004\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS4.3y} := d.r.e_{y4.3} \cdot \nu \cdot q = 0.008\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS3.2y} := d.r.e_{y3.2} \cdot \nu \cdot q = 0.011\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS2.1y} := d.r.e_{y2.1} \cdot \nu \cdot q = 0.013\ m < 0.005 \cdot H_{etaj} = 0.02\ m$

$d.r_{SLS1x} := d.r.e_{1y} \cdot \nu \cdot q = 0.015\ m < 0.005 \cdot H_{parter} = 0.024\ m$

Deplasarile laterale la SLS verifica!

- la SLU - $EI_c = 0.5\ EI_{brut}$

$q = 4.725$

$d.r.e_{5x} := 0.019\ m$ $d.r.e_{5y} := 0.0214\ m$

$d.r.e_{4x} := 0.0174\ m$ $d.r.e_{4y} := 0.0196\ m$

$d.r.e_{3x} := 0.0146\ m$ $d.r.e_{3y} := 0.0163\ m$

$d.r.e_{2x} := 0.0107\ m$ $d.r.e_{2y} := 0.0118\ m$

$d.r.e_{1x} := 0.006\ m$ $d.r.e_{1y} := 0.0063\ m$

$d.r.e_{x5.4} := d.r.e_{5x} - d.r.e_{4x} = 0.002\ m$ $d.r.e_{y5.4} := d.r.e_{5y} - d.r.e_{4y} = 0.002\ m$

$d.r.e_{x4.3} := d.r.e_{4x} - d.r.e_{3x} = 0.003\ m$ $d.r.e_{y4.3} := d.r.e_{4y} - d.r.e_{3y} = 0.003\ m$

$d.r.e_{x3.2} := d.r.e_{3x} - d.r.e_{2x} = 0.004\ m$ $d.r.e_{y3.2} := d.r.e_{3y} - d.r.e_{2y} = 0.005\ m$

$d.r.e_{x2.1} := d.r.e_{2x} - d.r.e_{1x} = 0.005\ m$ $d.r.e_{y2.1} := d.r.e_{2y} - d.r.e_{1y} = 0.006\ m$

$T_1 := 2.035\ s$

$1 < c := 3 - 2.3 \cdot \frac{T_1}{T_c} = -3.686 < \frac{\sqrt{T_c \cdot q}}{1.7} = 1.07\ s^{\frac{1}{2}} \Rightarrow c := 1.0$

$d.r_{SLS5.4x} := d.r.e_{x5.4} \cdot c \cdot q = 0.008\ m < 0.025 \cdot H_{etaj} = 0.101\ m$

$d.r_{SLU4.3x} := d.r.e_{x4.3} \cdot c \cdot q = 0.013\ m < 0.025 \cdot H_{etaj} = 0.101\ m$

$d.r_{SLU3.2x} := d.r.e_{x3.2} \cdot c \cdot q = 0.018\ m < 0.025 \cdot H_{etaj} = 0.101\ m$

$d.r_{SLU2.1x} := d.r.e_{x2.1} \cdot c \cdot q = 0.022\ m < 0.025 \cdot H_{parter} = 0.121\ m$

$d.r_{SLS5.4y} := d.r.e_{y5.4} \cdot c \cdot q = 0.009\ m < 0.025 \cdot H_{etaj} = 0.101\ m$

$d.r_{SLU4.3y} := d.r.e_{y4.3} \cdot c \cdot q = 0.016\ m < 0.025 \cdot H_{etaj} = 0.101\ m$

$d.r_{SLU3.2y} := d.r.e_{y3.2} \cdot c \cdot q = 0.021\ m < 0.025 \cdot H_{etaj} = 0.101\ m$

$d.r_{SLU2.1y} := d.r.e_{y2.1} \cdot c \cdot q = 0.026\ m < 0.025 \cdot H_{parter} = 0.121\ m$

Armare placă

$c_{nom} := 2\ cm$
$b := 1\ m \qquad d := h_p - c_{nom} = 0.1\ m$

Beton C20/25 Otel Bst500
$f_{ctm} := 1.9\ MPa \qquad f_{yk} := 500\ MPa \qquad f_{yd} := \frac{f_{yk}}{1.15} = 434.783\ MPa$

$0.0013 \cdot b \cdot d = 1.3\ cm^2$

$0.26 \cdot \frac{f_{ctm}}{f_{yk}} \cdot b \cdot d = 0.988\ cm^2$ => $A_{s.min} := 1.3\ cm^2$ <=> $\phi 6$/200mm

$A_{s.max} := 0.04\ b \cdot h_p = 48\ cm^2$

$s_{max} := 1.5 \cdot h_p = 180\ mm$ -distanța maximă între armăturile principale
$s_{max.arm.rep} := 2.5\ h_p = 300\ mm$ -distanța maximă între armăturile de repartitie

4.1. Armare camp

a. Armarea placa colt stanga sus

- armatura pe directia longitudinala (M1-1)

$M_c := 6.61\ kN \cdot m$
$h_p = 0.12\ m$
$b := 1\ m$
$d := h_p - c_{nom} - 8\ mm - \frac{8\ mm}{2} = 8.8\ cm$

$M_{Ed} := M_c = 6.61\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.064 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.066$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.787\ cm^2$ => aleg $\phi 6$/150 mm $A_{ef.1.x} := 1.89\ cm^2$

- armatura pe directia transversala (M2-2)

$M_c := 7.82\ kN \cdot m$
$h_p = 0.12\ m$
$b := 1\ m$
$d := h_p - c_{nom} - \frac{6\ mm}{2} = 9.7\ cm$

$M_{Ed} := M_c = 7.82\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.062 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.064$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.916\ cm^2$ => aleg $\phi 6$/130 mm $A_{ef.1.x} := 2.17\ cm^2$

b. Armarea placa sus în dreapta casei de scară

- armătură pe direcția longitudinală (M1-1)

$M_c := 6.71\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \left(8\ mm - \frac{8\ mm}{2}\right) = 9.6\ cm$

$M_{Ed} := M_c = 6.71\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.055 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.056$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.654\ cm^2$ => aleg $\phi 6/150$ mm $\qquad A_{ef.1.x} := 1.89\ cm^2$

- armătură pe direcția transversală (M2-2)

$M_c := 8.63\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{6\ mm}{2} = 9.7\ cm$

$M_{Ed} := M_c = 8.63\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.069 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.071$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 2.122\ cm^2$ => aleg $\phi 6/130$ mm $\qquad A_{ef.1.x} := 2.17\ cm^2$

c. Armarea placa colț dreapta sus

- armătură pe direcția longitudinală (M1-1)

$M_c := 6.40 \cdot kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \left(8\ mm - \frac{8\ mm}{2}\right) = 9.6\ cm$

$M_{Ed} := M_c = 6.4\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.052 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.054$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.575\ cm^2$ => aleg $\phi 6/150$ mm $\qquad A_{ef.1.x} := 1.89\ cm^2$

- armătură pe direcția transversală (M2-2)

$M_c := 7.70\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$

$M_{Ed} := M_c = 7.7\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.063 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.065$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.907\ cm^2$ => aleg $\phi 6/130$ mm $A_{ef.1.x} := 2.17\ cm^2$

d. Armarea placa colț dreapta jos

<=> armare placa colț dreapta sus

e. Armarea placa colț stânga jos

- armătură pe direcția longitudinală (M1-1)

$M_c := 6.53 \cdot kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \left(8\ mm - \frac{8\ mm}{2}\right) = 9.6\ cm$

$M_{Ed} := M_c = 6.53\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.053 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.055$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.608\ cm^2$ => aleg $\phi 6/150$ mm $A_{ef.1.x} := 1.89\ cm^2$

- armătură pe direcția transversală (M2-2)

$M_c := 7.70\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$

$M_{Ed} := M_c = 7.7\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.063 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.065$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.907\ cm^2$ => aleg $\phi 6/130$ mm $A_{ef.1.x} := 2.17\ cm^2$

f. Armarea plăci jos mijloc (două plăci)

- armătură pe direcția longitudinală (M1-1)

$M_c := 6.62 \cdot kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \left(8\ mm - \frac{8\ mm}{2}\right) = 9.6\ cm$

$M_{Ed} := M_c = 6.62\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.054 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.055$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.631\ cm^2$ => aleg $\phi 6/150$ mm $\qquad A_{ef.1.x} := 1.89\ cm^2$

- armătură pe direcția transversală (M2-2)

$M_c := 8.50\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$

$M_{Ed} := M_c = 8.5\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.069 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.072$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 2.112\ cm^2$ => aleg $\phi 6/130$ mm $\qquad A_{ef.1.x} := 2.17\ cm^2$

g. Armarea plăci mijloc mijloc (patru plăci)

- armătură pe direcția longitudinală (M1-1)

$M_c := 4.50\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \left(8\ mm - \frac{8\ mm}{2}\right) = 9.6\ cm$

$M_{Ed} := M_c = 4.5\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.037 \qquad \omega_{eff} := 1 - \sqrt{\left(1 - 2 \cdot \mu_{cc.eff}\right)} = 0.037$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.099\ cm^2$ => aleg $\phi 6/150$ mm $\qquad A_{ef.1.x} := 1.89\ cm^2$

- armătură pe direcția transversală (M2-2)

$M_c := 6.2\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$$

$$M_{Ed} := M_c = 6.2\ kN \cdot m$$

$$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.05 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.052$$

$$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.525\ cm^2$$ => aleg $\phi 6$/150 mm $\qquad A_{ef.1.x} := 1.89\ cm^2$

4.2. Armare reazem

a. Armarea placa colt stanga sus

- armătură pe direcția longitudinală (M1-1)

$$M_r := 10.66\ kN \cdot m$$

$$h_p = 0.12\ m$$

$$b := 1\ m$$ -dreapta

$$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$$

$$M_{Ed} := M_r = 10.66\ kN \cdot m$$

$$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.087 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.091$$

$$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 2.676\ cm^2$$ => aleg $\phi 8$/150 mm $\qquad A_{ef.1.x} := 3.35\ cm^2$

- armătură pe direcția transversală (M2-2)

$$M_r := 12.77\ kN \cdot m$$

$$h_p = 0.12\ m$$

$$b := 1\ m$$ -jos

$$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$$

$$M_{Ed} := M_r = 12.77\ kN \cdot m$$

$$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.104 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.11$$

$$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 3.237\ cm^2$$ => aleg $\phi 8$/150 mm $\qquad A_{ef.1.x} := 3.35\ cm^2$

b. Armarea placa sus în dreapta casei de scară

- armătură pe direcția longitudinală (M1-1)

$$M_r := 10.45\ kN \cdot m$$

$$h_p = 0.12\ m$$

$$b := 1\ m$$ -stanga

$$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$$

$$M_{Ed} := M_r = 10.45\ kN \cdot m$$

$$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.085 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.089$$

$$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 2.62\ cm^2$$ => aleg $\phi 8/150$ mm $$A_{ef.1.x} := 3.35\ cm^2$$

- armătură pe direcția longitudinală (M1-1)

$$M_r := 13.35\ kN \cdot m$$

$$h_p = 0.12\ m$$

$$b := 1\ m$$ -dreapta

$$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$$

$$M_{Ed} := M_r = 13.35\ kN \cdot m$$

$$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.109 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.115$$

$$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 3.394\ cm^2$$ => aleg $\phi 10/200$ mm $$A_{ef.1.x} := 3.93\ cm^2$$

- armătură pe direcția transversală (M2-2)

$$M_r := 11.62\ kN \cdot m$$

$$h_p = 0.12\ m$$

$$b := 1\ m$$ -jos

$$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$$

$$M_{Ed} := M_r = 11.62\ kN \cdot m$$

$$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.095 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.1$$

$$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 2.93\ cm^2$$ => aleg $\phi 8/150$ mm $$A_{ef.1.x} := 3.35\ cm^2$$

c. Armarea placa colț dreapta sus

armare ca la placa din dreapta casei de scara

d. Armarea placa colț dreapta jos

<=> armare placa colț dreapta sus

e. Armarea placa colț stânga jos

<=> armare placa colț dreapta sus

f. Armarea plăci jos mijloc (două plăci)

- armătură pe direcția longitudinală (M1-1)

$M_r := 13.90 \cdot kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$ -reazemul dintre plăci si reazemul comun cu placile exterioare

$M_{Ed} := M_r = 13.9\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.113$ $\omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.12$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 3.543\ cm^2$ => aleg $\phi 10/200$ mm $A_{ef.1.x} := 3.93\ cm^2$

- armătură pe direcția transversală (M2-2)

$M_r := 13.54\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$

$M_{Ed} := M_r = 13.54\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.11$ $\omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.117$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 3.446\ cm^2$ => aleg $\phi 10/200$ mm $A_{ef.1.x} := 3.93\ cm^2$

g. Armare plăci mijloc mijloc (patru plăci)

- armătură pe direcția longitudinală (M1-1)

$M_r := 10.50\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$

$M_{Ed} := M_r = 10.5\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.085$ $\omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.089$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 2.633\ cm^2$ => aleg $\phi 8/150$ mm $A_{ef.1.x} := 3.35\ cm^2$

4.3. Armare pe margini

$M_r := 7.62\ kN \cdot m$

$h_p = 0.12\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 9.6\ cm$

$M_{Ed} := M_r = 7.62\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.062 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.064$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 1.886\ cm^2$

=> aleg $\phi 8$/200 mm $\qquad A_{ef.1.x} := 2.51\ cm^2$

5. Lungimi de ancorare si suparpunere

-ancorare $\phi 10$

$\phi := 10\ mm \qquad \sigma_{sd} := f_{yd} = 434.783\ MPa \quad f_{bd} := 2.2\ MPa$

$l_{b.rqd} := 40\ cm \qquad c_d := 35\ mm$

$\alpha_1 := 1 \qquad \alpha_2 := 1 - \frac{0.15 \cdot (c_d - \phi)}{\phi} = 0.625 \qquad \alpha_4 := 0.7 \qquad \alpha_5 := 1$

$\alpha_3 := 1 \qquad \alpha_6 := 1.5$

$l_{bd} := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot \alpha_6 \cdot l_{b.rqd} = 26.25\ cm$

Armare grinda longitudinala

Beton C20/25 $f_{ck} := 20\ MPa$ $f_{ctm} := 2.2\ MPa$ $f_{cd} := \frac{f_{ck}}{1.5} = 13.333\ MPa$ $f_{ctd} := 1\ MPa$

Oțel Bst500S $f_{yk} := 500\ MPa$ $f_{yd} := \frac{f_{yk}}{1.15} = 434.783\ MPa$

-Armare longitudinala

6.1. Acoperirea cu beton

$c_{min.sl} := \max(20\ mm, 25\ mm, 10\ mm) = 25\ mm$

$c_{nom.sl} := 25\ mm + 10\ mm = 35\ mm$

$c_{nom.sw} := c_{nom.sl} - 8\ mm = 27\ mm$

$c_{nom} := 35\ mm$

6.2. Înaltimea utila a grinzii

$d := h_{gl} - c_{nom} - \frac{18\ mm}{2} = 556\ mm$

6.3. Distanța dintre armaturile de beton armat

$s_{n.min} := \max(20\ mm, 16\ mm + 5\ mm, 20\ mm) = 21\ mm$

6.4. Dimensionarea armaturii

$A_{s.min} := 0.5 \cdot \left(\frac{f_{ctm}}{f_{yk}}\right) \cdot b_{gl} \cdot d = 3.67\ cm^2$ - cantitatea minima de armatura conf. P100

$A_{s.max} := 0.04 \cdot h_{gl} \cdot b_{gl} = 72\ cm^2$

Valorile momentului

$M_{Ed.rc} := 137.1\ kN \cdot m$
$M_{Ed.rm} := 117.58\ kN \cdot m$

$M_{Ed.c} := 68.15\ kN \cdot m$

REAZEM CENTRAL

$$\mu_{st} := \frac{M_{Ed.rc}}{f_{cd} \cdot b_{gl} \cdot d^2} = 0.111 \qquad \omega_{st} := 1 - \sqrt{(1 - 2 \cdot \mu_{st})} = 0.118$$

$$A_{s.nec} := \omega_{st} \cdot b_{gl} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 6.026\ cm^2 \quad \text{=> aleg } 4\ \phi 14 \qquad A_{s.eff.rc} := 6.16\ cm^2$$

$$d_{eff} := h_{gl} - c_{nom} - 8\ mm - \frac{14\ mm}{2} = 55\ cm$$

Limitarea zonei comprimate in zone plastic potentiale:

$$x_1 := \frac{A_{s.eff.rc} \cdot f_{yd}}{b_{gl} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 8.37\ cm \qquad x_1 < 0.25\ d_{eff} = 1$$

Verificarea capacitatii portante:

$$z_{rc} := d_{eff} - \frac{0.8 \cdot x_1}{2} = 516.522\ mm$$

$$M_{Rd.rc.lg} := A_{s.eff.rc} \cdot f_{yd} \cdot z_{rc} = 138.338\ kN \cdot m \qquad M_{Rd.rc.lg} > M_{Ed.rc} = 1$$

REAZEM MARGINAL

$$\mu_{rm} := \frac{M_{Ed.rm}}{f_{cd} \cdot b_{gl} \cdot d^2} = 0.095 \qquad \omega_{rm} := 1 - \sqrt{(1 - 2 \cdot \mu_{rm})} = 0.1$$

$$A_{s.nec} := \omega_{rm} \cdot b_{gl} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 5.12\ cm^2 \quad \text{=> aleg } 4\ \phi 14 \qquad A_{s.eff.rm} := 6.16\ cm^2$$

$$d_{eff} := h_{gl} - c_{nom} - 8\ mm - \frac{14\ mm}{2} = 55\ cm$$

Limitarea zonei comprimate in zone plastic potentiale:

$$x_1 := \frac{A_{s.eff.rm} \cdot f_{yd}}{b_{gl} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 8.37\ cm \qquad x_1 < 0.25\ d_{eff} = 1$$

Verificarea capacitatii portante:

$$z_{rm} := d_{eff} - \frac{0.8 \cdot x_1}{2} = 516.522\ mm$$

$$M_{Rd.rm.lg} := A_{s.eff.rc} \cdot f_{yd} \cdot z_{rm} = 138.338\ kN \cdot m \qquad M_{Rd.rm.lg} > M_{Ed.rm} = 1$$

CAMP central

$$b_1 := \frac{l_2 - h_{st}}{2} = 2.575\ m \qquad l := 0.7 \cdot (l_2 - h_{st}) = 3.605\ m$$

$$b_{eff.i} := min\left(b_1, 0.2 \cdot b_{st} + 0.1\ l, 0.2\ l, 4\ h_p\right) = 0.451\ m$$

$$b_{eff} := 2 \cdot b_{eff.i} + b_{gl} = 1.201\ m \qquad \eta := 1 \text{ pt. beton <C50/60}$$

$$\mu_c := \frac{M_{Ed.c}}{b_{gl} \cdot d^2 \cdot f_{cd}} = 0.055 \qquad < \qquad \eta \frac{b_{eff}}{b_{gl}} \cdot \frac{h_p}{d} \cdot \left(1 - 0.5 \cdot \frac{h_p}{d}\right) = 0.771$$

=> sect. T aplicam relatiile de la grinda dr. inlocuind b.gr cu b.eff (axa neutra este in placa)

$$\mu_c := \frac{M_{Ed.c}}{b_{eff} \cdot d^2 \cdot f_{cd}} = 0.014 \qquad \omega_c := 1 - \sqrt{(1 - 2 \cdot \mu_c)} = 0.014$$

$$A_{s.nec} := \omega_c \cdot b_{eff} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 2.839\ cm^2 \quad \text{=> aleg } 3\phi 14 \qquad A_{s.eff.c} := 4.62\ cm^2$$

$$d_{eff} := h_{gl} - c_{nom} - 8\ mm - \frac{14\ mm}{2} = 55\ cm$$

Verificarea capacitatii portante:

$$x_1 := \frac{A_{s.eff.c} \cdot f_{yd}}{b_{eff} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 1.568\ cm$$

$$z_1 := d_{eff} - \frac{0.8 \cdot x_1}{2} = 543.728\ mm$$

$$M_{Rd.c.lg} := A_{s.eff.c} \cdot f_{yd} \cdot z_1 = 109.218\ kN \cdot m \qquad M_{Rd.c.lg} > M_{Ed.c} = 1$$

CAMP marginal

$$b_1 := \frac{l_1 - h_{st}}{2} = 2.3\ m \qquad l := 0.7 \cdot (l_1 - h_{st}) = 3.22\ m$$

$$b_{eff.i} := min\left(b_1, 0.2 \cdot b_{st} + 0.1\ l, 0.2\ l, 2\ h_p\right) = 0.24\ m$$

$$b_{eff} := 1 \cdot b_{eff.i} + b_{gl} = 0.54\ m \qquad \eta := 1 \text{ pt. beton <C50/60}$$

$$\mu_c := \frac{M_{Ed.c}}{b_{gl} \cdot d^2 \cdot f_{cd}} = 0.055 \qquad < \qquad \eta \frac{b_{eff}}{b_{gl}} \cdot \frac{h_p}{d} \cdot \left(1 - 0.5 \cdot \frac{h_p}{d}\right) = 0.347$$

=> sect. T aplicam relatiile de la grinda dr. inlocuind b.gr cu b.eff (axa neutra este in placa)

$$\mu_c := \frac{M_{Ed.c}}{b_{eff} \cdot d^2 \cdot f_{cd}} = 0.031 \qquad \omega_c := 1 - \sqrt{(1 - 2 \cdot \mu_c)} = 0.031$$

$$A_{s.nec} := \omega_c \cdot b_{eff} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 2.864\ cm^2$$ => aleg $3\phi 14$ $$A_{s.eff.c} := 4.62\ cm^2$$

$$d_{eff} := h_{gl} - c_{nom} - 8\ mm - \frac{14\ mm}{2} = 55\ cm$$

Verificarea capacitatii portante:

$$x_1 := \frac{A_{s.eff.c} \cdot f_{yd}}{b_{eff} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 3.487\ cm$$

$$z_1 := d_{eff} - \frac{0.8 \cdot x_1}{2} = 536.051\ mm$$

$$M_{Rd.c.lg} := A_{s.eff.c} \cdot f_{yd} \cdot z_1 = 107.676\ kN \cdot m \qquad M_{Rd.c.lg} > M_{Ed.c} = 1$$

Diametrul armaturilor long. care trec prin nodurile grinda-stalp se limiteaza superior prin conditiile:

$$d_{bl} := \frac{10 \cdot 1 + 0.8 \cdot \nu_d}{1 + 0.75 \cdot \frac{A_{s.eff.c}}{A_{s.eff.rc}}} \cdot \frac{f_{ctm}}{f_{yd}} \cdot h_{st} = 15.156\ mm$$ -diametru maxim nod central

$$d_{bl} := 10 \cdot (1 + 0.8 \cdot \nu_d) \cdot \frac{f_{ctm}}{f_{yd}} \cdot h_{st} = 31.878\ mm$$ -diametru maxim nod de capat

Verificarea capacitatii portante $2\phi 14$: $$A_{s.eff} := 3.08\ cm^2$$

$$x_1 := \frac{A_{s.eff} \cdot f_{yd}}{b_{eff} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 2.325\ cm$$

$$z_1 := d_{eff} - \frac{0.8 \cdot x_1}{2} = 540.7\ mm$$

$$M_{Rd} := A_{s.eff} \cdot f_{yd} \cdot z_1 = 72.407\ kN \cdot m \qquad M_{Rd} > M_{Ed} = 1$$

Lungimi de ancoraj:

PARTEA SUPERIOARA

$l_{bd.rqd} := 96\ cm \quad \alpha_1 := 1 \quad \phi := 14\ mm \quad c_d := min\left(58\ mm, c_{nom}\right) = 3.5\ cm$

$\alpha_2 := 1 - 0.15\ \frac{\left(c_d - \phi\right)}{\phi} = 0.775$

$K := 0.05 \quad \lambda := 1 \quad \alpha_3 := 1 - K \cdot \lambda = 0.95$

$\alpha_4 := 0.7$

$\alpha_5 := 1$

$l_{bd} := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{bd.rqd} = 49.476\ cm$ Aleg lbd=60cm

$\alpha_6 := 1.5$

$l_0 := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot \alpha_6 \cdot l_{bd.rqd} = 74.214\ cm$

PARTEA INFERIOARA

$l_{bd.rqd} := 38\ cm \quad \alpha_1 := 1 \quad \phi := 14\ mm \quad c_d := min\left(58\ mm, c_{nom}\right) = 3.5\ cm$

$\alpha_2 := 1 - 0.15\ \frac{\left(c_d - \phi\right)}{\phi} = 0.775$

$K := 0.05 \quad \lambda := 1 \quad \alpha_3 := 1 - K \cdot \lambda = 0.95$

$\alpha_4 := 0.7$

$\alpha_5 := 1$

$l_{bd} := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{bd.rqd} = 19.584\ cm$ Aleg lbd=60cm

$\alpha_6 := 1.5$

$l_0 := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot \alpha_6 \cdot l_{bd.rqd} = 29.376\ cm$

-Armare transversala

$l_0 := l_1 - h_{st} = 4.6\ m$ $\gamma_{Rd} := 1$ DCM (factor de suprarezistenta din consolidarea otelului)

Valorile momentelor capabile reazeme

REAZEM DE CAPAT

$M_{db.1} := \gamma_{Rd} \cdot M_{Rd.rm.lg} \cdot 1 = 138.338\ kN \cdot m$ $M_{db.2} := \gamma_{Rd} \cdot M_{Rd.c.lg} \cdot 1 = 107.676\ kN \cdot m$

$$V_{Ed.max.GS} := \frac{|M_{db.1}| + |M_{db.2}|}{l_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{t_1}{2} + \frac{t_2}{2}\right) \cdot \frac{l_0}{2} + \left(h_{gl} \cdot b_{gl} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{l_0}{2} = 124.041\ kN$$

$$V_{Ed.min.GS} := -\frac{|M_{db.1}| + |M_{db.2}|}{l_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{t_1}{2} + \frac{t_2}{2}\right) \cdot \frac{l_0}{2} + \left(h_{gl} \cdot b_{gl} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{l_0}{2} = 17.078\ kN$$

$\xi := \frac{V_{Ed.min.GS}}{V_{Ed.max.GS}} = 0.138$ >-0.5 $V_{Ed.max.GS} < (2+\xi) \cdot b_{gl} \cdot d_{eff} \cdot f_{ctd} = 1$

$(2+\xi) \cdot b_{gl} \cdot d_{eff} \cdot f_{ctd} = 352.718\ kN$

Armarea se face conf. SR EN 1992-1-1

$V_{Ed.GF} := 101.4\ kN$

$V_{Ed} := \max(V_{Ed.GF}, V_{Ed.max.GS}, V_{Ed.min.GS}) = 124.041\ kN$

$l_{cr} := h_{gl} = 0.6\ m$

$\rho_l := \frac{A_{s.eff.rm}}{b_{gl} \cdot d} = 0.004$ <0.02

$C_{Rd.c} := 0.12$ $\eta := 1$ $k := 1 + \sqrt{\frac{200\ mm}{d_{eff}}} = 1.603$ <2

$$V_{Rd.c} := \left(C_{Rd.c} \cdot \eta \cdot k \cdot \left(100 \cdot \rho_l \cdot \frac{f_{ck}}{MPa}\right)^{\frac{1}{3}}\right) \cdot b_{gl} \cdot d \cdot MPa = 62.487\ kN$$

$$V_{Rd.c.min} := 0.035 \cdot k^{\frac{3}{2}} \cdot \left(\frac{f_{ck}}{MPa}\right)^{\frac{1}{2}} \cdot b_{gl} \cdot d \cdot MPa = 52.989\ kN$$

$\text{if}(V_{Ed} \geq V_{Rd.c}, \text{“armatura transv”}, \text{“nu”}) = \text{“armatura transv”}$

$a_{cw} := 1$ $\nu_1 := 0.6\left(1 - \frac{f_{ck}}{200\ MPa}\right) = 0.54$ $\theta := 21.8\ deg$ $\alpha_1 := 90\ deg$

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rm} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 384.7\ kN \qquad V_{Ed} = 124.041\ kN$$

$$ctg(\theta) := 1$$

Distanta dintre etrieri a.i. $V_{ed} < V_{Rds}$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2$$

$$s_v := \frac{A_{sw} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 18.213\ cm$$

Distanta maxima intre etrieri zona critica:

$$s_{max} := min\left(\frac{h_{gl}}{4}, 200\ mm, 8 \cdot 14\ mm\right) = 112\ mm$$ CLASA M

$Aleg$ $\quad s := 10\ cm$

Verificare procent de armatura la Ved $\quad \alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gl} \cdot \sin(\alpha)} = 0.003 \qquad \rho_{w.cr.min} := 0.002$$

Verificarea cedarii ductile la Ved

$$\rho_{w.min} := \frac{0.08 \cdot \sqrt{25}}{434.783} = 9.2 \cdot 10^{-4}$$

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta) = 225.922\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

Dispunere etrieri dupa l.cr

$$V_{Ed} := 110\ kN$$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2$$

$$s_v := \frac{A_{sw} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 20.538\ cm \qquad ctg(\theta) := 1$$

Distanta maxima intre etrieri zona critica:

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rm} \cdot b_{gt} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 384.7\ kN \qquad V_{Ed} = 110\ kN$$

Calculul unghiului θ

$$ctg\theta := 2.5 - \left(\frac{\left(\left(V_{Ed} - V_{Rd.c} \right) \cdot 1.5 \right)}{V_{Rd.max} - V_{Rd.c}} \right) = 2.279$$

$$s_{max} := min\left(0.75 \cdot d_{eff}, 300\ mm\right) = 300\ mm$$

$Aleg \qquad s := 20\ cm$

Verificare procent de armatura la Ved $\qquad \alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gt} \cdot \sin(\alpha)} = 0.002 \qquad \rho_{w.min} := \frac{0.08 \cdot \sqrt{25}}{434.783} = 9.2 \cdot 10^{-4}$$

Verificarea cedarii ductile la Ved

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rc} \cdot f_{yd} \cdot ctg(\theta) = 112.961\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

$l_0 := l_2 - h_{st} = 5.15\ m$ $\gamma_{Rd} := 1$ DCM (factor de suprarezistenta din consolidarea otelului)

Valorile momentelor capabile reazeme

DESCHIDERE CENTRALA

$M_{db.1} := \gamma_{Rd} \cdot M_{Rd.rm.lg} \cdot 1 = 138.338\ kN \cdot m$ $M_{db.2} := \gamma_{Rd} \cdot M_{Rd.c.lg} \cdot 1 = 107.676\ kN \cdot m$

$$V_{Ed.max.GS} := \frac{|M_{db.1}| + |M_{db.2}|}{l_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{t_1}{2} + \frac{t_2}{2}\right) \cdot \frac{l_0}{2} + \left(h_{gl} \cdot b_{gl} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{l_0}{2} = 126.766\ kN$$

$$V_{Ed.min.GS} := -\frac{|M_{db.1}| + |M_{db.2}|}{l_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{t_1}{2} + \frac{t_2}{2}\right) \cdot \frac{l_0}{2} + \left(h_{gl} \cdot b_{gl} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{l_0}{2} = 31.227\ kN$$

$\xi := \frac{V_{Ed.min.GS}}{V_{Ed.max.GS}} = 0.246$ >-0.5 $V_{Ed.max.GS} < (2 + \xi) \cdot b_{gl} \cdot d_{eff} \cdot f_{ctd} = 1$

$(2 + \xi) \cdot b_{gl} \cdot d_{eff} \cdot f_{ctd} = 370.645\ kN$

Armarea se face conf. SR EN 1992-1-1

$V_{Ed.GF} := 108.5\ kN$

$V_{Ed} := \max(V_{Ed.GF}, V_{Ed.max.GS}, V_{Ed.min.GS}) = 126.766\ kN$

$l_{cr} := h_{st} = 0.45\ m$

$\rho_l := \frac{A_{s.eff.rm}}{b_{gl} \cdot d} = 0.004$ <0.02

$C_{Rd.c} := 0.12$ $\eta := 1$ $k := 1 + \sqrt{\frac{200\ mm}{d_{eff}}} = 1.603$ <2

$$V_{Rd.c} := \left(C_{Rd.c} \cdot \eta \cdot k \cdot \left(100 \cdot \rho_l \cdot \frac{f_{ck}}{MPa}\right)^{\frac{1}{3}}\right) \cdot b_{gl} \cdot d \cdot MPa = 62.487\ kN$$

$$V_{Rd.c.min} := 0.035 \cdot k^{\frac{3}{2}} \cdot \left(\frac{f_{ck}}{MPa}\right)^{\frac{1}{2}} \cdot b_{gl} \cdot d \cdot MPa = 52.989\ kN$$

$\text{if}(V_{Ed} \geq V_{Rd.c}, \text{“armatura transv”}, \text{“nu”}) = \text{“armatura transv”}$

$a_{cw} := 1$ $\nu_1 := 0.6 \left(1 - \frac{f_{ck}}{200\ MPa}\right) = 0.54$ $\theta := 21.8\ deg$ $\alpha_1 := 90\ deg$

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rc} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 384.7\ kN \qquad V_{Ed} = 126.766\ kN$$

$$ctg(\theta) := 1$$

Distanta dintre etrieri a.i. $V_{ed} < V_{Rds}$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2$$

$$s_v := \frac{A_{sw} \cdot z_{rc} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 17.822\ cm$$

Distanta maxima intre etrieri zona critica:

$$s_{max} := min\left(\frac{h_{gl}}{4}, 200\ mm, 8 \cdot 14\ mm\right) = 112\ mm$$ CLASA M

$$Aleg \qquad s := 10\ cm$$

Verificare procent de armatura la Ved $\alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gl} \cdot \sin(\alpha)} = 0.003 \qquad \rho_{w.cr.min} := 0.002$$

Verificarea cedarii ductile la Ved

$$\rho_{w.min} := \frac{0.08 \cdot \sqrt{25}}{434.783} = 9.2 \cdot 10^{-4}$$

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta) = 225.922\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

Dispunere etrieri dupa l.cr

$$V_{Ed} := 112\ kN$$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2 \qquad ctg(\theta) := 1$$

$$s_v := \frac{A_{sw} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 20.172\ cm$$

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rm} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 384.7\ kN \qquad V_{Ed} = 112\ kN$$

Calculul unghiului θ

$$ctg\theta := 2.5 - \left(\frac{\left(\left(V_{Ed} - V_{Rd.c} \right) \cdot 1.5 \right)}{V_{Rd.max} - V_{Rd.c}} \right) = 2.27$$

$$s_{max} := min\left(0.75 \cdot d_{eff}, 300\ mm\right) = 300\ mm$$

$Aleg \qquad s := 20\ cm$

Verificare procent de armatura la Ved $\qquad \alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gl} \cdot \sin(\alpha)} = 0.002 \qquad \rho_{w.min} := \frac{0.08 \cdot \sqrt{25}}{434.783} = 9.2 \cdot 10^{-4}$$

Verificarea cedarii ductile la Ved

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rc} \cdot f_{yd} \cdot ctg(\theta) = 112.961\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

Distanta dintre zona critica si Vrd.c estemica astfel ca aleg sa mergu cu acelasi pas pana la Vrd.c iar de acolo voi dispune etrieri constructivi la pas de:

$$s_{b.max} := min\left(0.75 \cdot d_{eff}, 300\ mm\right) = 0.3\ m$$

Armare grinda transversala

Beton C20/25 $f_{ck} := 20\ MPa$ $f_{ctm} := 2.2\ MPa$ $f_{cd} := \frac{f_{ck}}{1.5} = 13.333\ MPa$ $f_{ctd} := 1\ MPa$

Oțel Bst500S $f_{yk} := 500\ MPa$ $f_{yd} := \frac{f_{yk}}{1.15} = 434.783\ MPa$

-Armare longitudinala

Acoperirea cu beton

$c_{min.sl} := \max(20\ mm, 25\ mm, 10\ mm) = 25\ mm$

$c_{nom.sl} := 25\ mm + 10\ mm = 35\ mm$

$c_{nom.sw} := c_{nom.sl} - 8\ mm = 27\ mm$

$c_{nom} := 35\ mm$

Inaltimea utila a grinzii

$d := h_{gt} - c_{nom} - \frac{18\ mm}{2} = 456\ mm$

Distanta dintre armaturile de beton armat

$s_{n.min} := \max(20\ mm, 16\ mm + 5\ mm, 20\ mm) = 21\ mm$

Dimensionarea armaturii

$A_{s.min} := 0.5 \cdot \left(\frac{f_{ctm}}{f_{yk}}\right) \cdot b_{gt} \cdot d = 3.01\ cm^2$ - cantitatea minimă de armătură conf. P100

$A_{s.max} := 0.04 \cdot h_{gt} \cdot b_{gt} = 60\ cm^2$

Valorile momentului

$M_{Ed.rc} := 125.3\ kN \cdot m$
$M_{Ed.rm} := 117.5\ kN \cdot m$

$M_{Ed.c} := 53\ kN \cdot m$

REAZEM CENTRAL

$$\mu_{st} := \frac{M_{Ed.rc}}{f_{cd} \cdot b_{gt} \cdot d^2} = 0.151 \qquad \omega_{st} := 1 - \sqrt{(1 - 2 \cdot \mu_{st})} = 0.164$$

$$A_{s.nec} := \omega_{st} \cdot b_{gt} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 6.885\ cm^2$$ => aleg $2\ \phi 16 + 2\ \phi 14$ $A_{s.eff.rc} := 7.10\ cm^2$

$$d_{eff} := h_{gt} - c_{nom} - 8\ mm - \frac{15\ mm}{2} = 44.95\ cm$$

Limitarea zonei comprimate in zone plastic potentiale:

$$x_1 := \frac{A_{s.eff.rc} \cdot f_{yd}}{b_{gt} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 9.647\ cm \qquad x_1 < 0.25\ d_{eff} = 1$$

Verificarea capacitatii portante:

$$z_{rc} := d_{eff} - \frac{0.8 \cdot x_1}{2} = 410.913\ mm$$

$$M_{Rd.rc.tr} := A_{s.eff.rc} \cdot f_{yd} \cdot z_{rc} = 126.847\ kN \cdot m \qquad M_{Rd.rc.tr} > M_{Ed.rc} = 1$$

REAZEM MARGINAL

$$\mu_{rm} := \frac{M_{Ed.rm}}{f_{cd} \cdot b_{gt} \cdot d^2} = 0.141 \qquad \omega_{rm} := 1 - \sqrt{(1 - 2 \cdot \mu_{rm})} = 0.153$$

$$A_{s.nec} := \omega_{rm} \cdot b_{gt} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 6.417\ cm^2$$ => aleg $2\ \phi 16 + 2\ \phi 14$ $A_{s.eff.rm} := 7.10\ cm^2$

$$d_{eff} := h_{gt} - c_{nom} - 8\ mm - \frac{15\ mm}{2} = 44.95\ cm$$

Limitarea zonei comprimate in zone plastic potentiale:

$$x_1 := \frac{A_{s.eff.rm} \cdot f_{yd}}{b_{gt} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 9.647\ cm \qquad x_1 < 0.25\ d_{eff} = 1$$

Verificarea capacitatii portante:

$$z_{rm} := d_{eff} - \frac{0.8 \cdot x_1}{2} = 410.913\ mm$$

$$M_{Rd.rm.tr} := A_{s.eff.rc} \cdot f_{yd} \cdot z_{rm} = 126.847\ kN \cdot m \qquad M_{Rd.rm.tr} > M_{Ed.rm} = 1$$

CAMP central

$$b_1 := \frac{t_2 - h_{st}}{2} = 1.65\ m \qquad b_2 := \frac{t_1 - h_{st}}{2} = 2.05\ m \qquad l := 0.7 \cdot (t_2 - h_{st}) = 2.31\ m$$

$$b_{eff.i} := min(b_2, b_1, 0.2 \cdot b_{st} + 0.1\ l, 0.2\ l, 4\ h_p) = 0.321\ m$$

$$b_{eff} := 2 \cdot b_{eff.i} + b_{gt} = 0.942\ m \qquad \eta := 1 \text{ pt. beton <C50/60}$$

$$\mu_c := \frac{M_{Ed.c}}{b_{gt} \cdot d^2 \cdot f_{cd}} = 0.064 \qquad < \qquad \eta \frac{b_{eff}}{b_{gt}} \cdot \frac{h_p}{d} \cdot \left(1 - 0.5 \cdot \frac{h_p}{d}\right) = 0.718$$

=> sect. T aplicam relatiile de la grinda dr. inlocuind b.gr cu b.eff (axa neutra este in placa)

$$\mu_c := \frac{M_{Ed.c}}{b_{eff} \cdot d^2 \cdot f_{cd}} = 0.02 \qquad \omega_c := 1 - \sqrt{(1 - 2 \cdot \mu_c)} = 0.021$$

$$A_{s.nec} := \omega_c \cdot b_{eff} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 2.701\ cm^2 \quad \text{=> aleg } 3\phi 14 \qquad A_{s.eff.c} := 4.62\ cm^2$$

$$d_{eff} := h_{gt} - c_{nom} - 8\ mm - \frac{14\ mm}{2} = 45\ cm$$

Verificarea capacitatii portante:

$$x_1 := \frac{A_{s.eff.c} \cdot f_{yd}}{b_{eff} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 1.999\ cm$$

$$z_1 := d_{eff} - \frac{0.8 \cdot x_1}{2} = 442.004\ mm$$

$$M_{Rd.c.tr} := A_{s.eff.c} \cdot f_{yd} \cdot z_1 = 88.785\ kN \cdot m \qquad M_{Rd.c.tr} > M_{Ed.c} = 1$$

CAMP marginall

$$b_1 := \frac{t_1 - h_{st}}{2} = 2.05\ m \qquad l := 0.7 \cdot (t_1 - h_{st}) = 2.87\ m$$

$$b_{eff.i} := min(b_1, 0.2 \cdot b_{st} + 0.1\ l, 0.2\ l, 2\ h_p) = 0.24\ m$$

$$b_{eff} := 1 \cdot b_{eff.i} + b_{gt} = 0.54\ m \qquad \eta := 1 \text{ pt. beton <C50/60}$$

$$\mu_c := \frac{M_{Ed.c}}{b_{gt} \cdot d^2 \cdot f_{cd}} = 0.064 \qquad < \qquad \eta \frac{b_{eff}}{b_{gt}} \cdot \frac{h_p}{d} \cdot \left(1 - 0.5 \cdot \frac{h_p}{d}\right) = 0.411$$

=> sect. T aplicam relatiile de la grinda dr. inlocuind b.gr cu b.eff (axa neutra este in placa)

$$\mu_c := \frac{M_{Ed.c}}{b_{eff} \cdot d^2 \cdot f_{cd}} = 0.035 \qquad \omega_c := 1 - \sqrt{(1 - 2 \cdot \mu_c)} = 0.036$$

$$A_{s.nec} := \omega_c \cdot b_{eff} \cdot d \cdot \frac{f_{cd}}{f_{yd}} = 2.722\ cm^2 \quad \text{=> aleg } 3\phi 14 \qquad A_{s.eff.c} := 4.62\ cm^2$$

$$d_{eff} := h_{gt} - c_{nom} - 8\ mm - \frac{14\ mm}{2} = 45\ cm$$

Verificarea capacitatii portante:

$$x_1 := \frac{A_{s.eff.c} \cdot f_{yd}}{b_{eff} \cdot 0.8 \cdot 1 \cdot f_{cd}} = 3.487\ cm$$

$$z_1 := d_{eff} - \frac{0.8 \cdot x_1}{2} = 436.051\ mm$$

$$M_{Rd.c} := A_{s.eff.c} \cdot f_{yd} \cdot z_1 = 87.589\ kN \cdot m \qquad M_{Rd.c} > M_{Ed.c} = 1$$

Diametrul armaturilor long. care trec prin nodurile grinda-stalp se limiteaza superior prin conditiile:

$$d_{bl} := \frac{10 \cdot 1 + 0.8 \cdot \nu_d}{1 + 0.75 \cdot \frac{A_{s.eff.c}}{A_{s.eff.rc}}} \cdot \frac{f_{ctm}}{f_{yd}} \cdot h_{st} = 15.914\ mm$$ -diametru maxim nod central

$$d_{bl} := 10 \cdot (1 + 0.8 \cdot \nu_d) \cdot \frac{f_{ctm}}{f_{yd}} \cdot h_{st} = 31.878\ mm$$ -diametru maxim nod de capat

Lungimi de ancoraj:

PARTEA SUPERIOARA

$$l_{bd.rqd} := 96\ cm \qquad \alpha_1 := 1 \qquad \phi := 14\ mm \qquad c_d := min(58\ mm, c_{nom}) = 3.5\ cm$$

$$\alpha_2 := 1 - 0.15 \frac{(c_d - \phi)}{\phi} = 0.775$$

$$K := 0.05 \qquad \lambda := 1 \qquad \alpha_3 := 1 - K \cdot \lambda = 0.95$$

$$\alpha_4 := 0.7$$

$$\alpha_5 := 1$$

$l_{bd} := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{bd.rqd} = 49.476\ cm$ Aleg lbd=60cm

PARTEA INFERIOARA

$l_{bd.rqd} := 38\ cm$ $\alpha_1 := 1$ $\phi := 14\ mm$ $c_d := min\left(58\ mm, c_{nom}\right) = 3.5\ cm$

$\alpha_2 := 1 - 0.15\ \frac{\left(c_d - \phi\right)}{\phi} = 0.775$

$K := 0.05$ $\lambda := 1$ $\alpha_3 := 1 - K \cdot \lambda = 0.95$

$\alpha_4 := 0.7$

$\alpha_5 := 1$

$l_{bd} := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{bd.rqd} = 19.584\ cm$ Aleg lbd=60cm

-Armare transversala

$t_0 := t_1 - h_{st} = 4.1\ m$ $\gamma_{Rd} := 1$ DCM (factor de suprarezistenta din consolidarea otelului)

Valorile momentelor capabile reazeme

REAZEM DE CAPAT

$M_{db.1} := \gamma_{Rd} \cdot M_{Rd.rm.tr} \cdot 1 = 126.847\ kN \cdot m$ $M_{db.2} := \gamma_{Rd} \cdot M_{Rd.c.tr} \cdot 1 = 88.785\ kN \cdot m$

$$V_{Ed.max.GS} := \frac{|M_{db.1}| + |M_{db.2}|}{t_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{l_1}{2} + \frac{l_2}{2}\right) \cdot \frac{t_0}{2} + \left(h_{gt} \cdot b_{gt} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{t_0}{2} = 129.14\ kN$$

$$V_{Ed.min.GS} := -\frac{|M_{db.1}| + |M_{db.2}|}{t_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{l_1}{2} + \frac{l_2}{2}\right) \cdot \frac{t_0}{2} + \left(h_{gt} \cdot b_{gt} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{t_0}{2} = 23.954\ kN$$

$\xi := \frac{V_{Ed.min.GS}}{V_{Ed.max.GS}} = 0.185$ >-0.5 $V_{Ed.max.GS} < (2+\xi) \cdot b_{gt} \cdot d_{eff} \cdot f_{ctd} = 1$

$(2+\xi) \cdot b_{gt} \cdot d_{eff} \cdot f_{ctd} = 295.041\ kN$

Armarea se face conf. SR EN 1992-1-1

$V_{Ed.GF} := 99.9\ kN$

$V_{Ed} := \max(V_{Ed.GF}, V_{Ed.max.GS}, V_{Ed.min.GS}) = 129.14\ kN$

$l_{cr} := h_{st} = 0.45\ m$

$\rho_l := \frac{A_{s.eff.rm}}{b_{gt} \cdot d} = 0.005$ <0.02

$C_{Rd.c} := 0.12$ $\eta := 1$ $k := 1 + \sqrt{\frac{200\ mm}{d_{eff}}} = 1.667$ <2

$$V_{Rd.c} := \left(C_{Rd.c} \cdot \eta \cdot k \cdot \left(100 \cdot \rho_l \cdot \frac{f_{ck}}{MPa}\right)^{\frac{1}{3}}\right) \cdot b_{gt} \cdot d_{eff} \cdot MPa = 58.898\ kN$$

$$V_{Rd.c.min} := 0.035 \cdot k^{\frac{3}{2}} \cdot \left(\frac{f_{ck}}{MPa}\right)^{\frac{1}{2}} \cdot b_{gt} \cdot d_{eff} \cdot MPa = 45.466\ kN$$

$\text{if}(V_{Ed} \geq V_{Rd.c}, \text{“armatura transv”}, \text{“nu”}) = \text{“armatura transv”}$

$a_{cw} := 1$ $\nu_1 := 0.6\left(1 - \frac{f_{ck}}{200\ MPa}\right) = 0.54$ $\theta := 21.8\ deg$ $\alpha_1 := 90\ deg$

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rm} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 306.044\ kN \quad V_{Ed} = 129.14\ kN$$

$$ctg(\theta) := 1$$

Distanta dintre etrieri a.i. $V_{ed} < V_{Rds}$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2$$

$$s_v := \frac{A_{sw} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 13.917\ cm$$

Distanta maxima intre etrieri zona critica:

$$s_{max} := min\left(\frac{h_{gt}}{4}, 200\ mm, 8 \cdot 14\ mm\right) = 112\ mm$$ CLASA M

$$Aleg \qquad s := 10\ cm$$

Verificare procent de armatura la Ved $\alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gl} \cdot \sin(\alpha)} = 0.003 \quad \rho_{w.cr.min} := 0.002$$

Verificarea cedarii ductile la Ved

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta) = 179.73\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

Dispunere etrieri dupa l.cr

$$V_{Ed} := 88\ kN$$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2$$

$$s_v := \frac{A_{sw} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 20.424\ cm \qquad ctg(\theta) := 1$$

Distanta maxima intre etrieri zona critica:

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rm} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 306.044\ kN \quad V_{Ed} = 88\ kN$$

Calculul unghiului θ

$$ctg\theta := 2.5 - \left(\frac{\left(\left(V_{Ed} - V_{Rd.c} \right) \cdot 1.5 \right)}{V_{Rd.max} - V_{Rd.c}} \right) = 2.323$$

$$s_{max} := min\left(0.75 \cdot d_{eff}, 300\ mm\right) = 300\ mm$$

Aleg $s := 20\ cm$

Verificare procent de armatura la Ved $\alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gl} \cdot \sin(\alpha)} = 0.002 \qquad \rho_{w.min} := \frac{0.08 \cdot \sqrt{25}}{434.783} = 9.2 \cdot 10^{-4}$$

Verificarea cedarii ductile la Ved

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rc} \cdot f_{yd} \cdot ctg(\theta) = 89.865\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

$t_0 := t_2 - h_{st} = 3.3\ m$ $\gamma_{Rd} := 1$ DCM (factor de suprarezistenta din consolidarea otelului)

Valorile momentelor capabile reazeme

DESCHIDERE CENTRALA

$M_{db.1} := \gamma_{Rd} \cdot M_{Rd.rm.tr} \cdot 1 = 126.847\ kN \cdot m$ $M_{db.2} := \gamma_{Rd} \cdot M_{Rd.c.tr} \cdot 1 = 88.785\ kN \cdot m$

$$V_{Ed.max.GS} := \frac{|M_{db.1}| + |M_{db.2}|}{t_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{l_1}{2} + \frac{l_2}{2}\right) \cdot \frac{t_0}{2} + \left(h_{gt} \cdot b_{gt} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{t_0}{2} = 126.954\ kN$$

$$V_{Ed.min.GS} := -\frac{|M_{db.1}| + |M_{db.2}|}{t_0} + (g_{k.pr} + 0.3 \cdot q_{k.total}) \cdot \left(\frac{l_1}{2} + \frac{l_2}{2}\right) \cdot \frac{t_0}{2} + \left(h_{gt} \cdot b_{gt} \cdot 25\ \frac{kN}{m^3}\right) \cdot \frac{t_0}{2} = -3.732\ kN$$

$\xi := \frac{V_{Ed.min.GS}}{V_{Ed.max.GS}} = -0.029$ >-0.5 $V_{Ed.max.GS} < (2 + \xi) \cdot b_{gl} \cdot d_{eff} \cdot f_{ctd} = 1$

$(2 + \xi) \cdot b_{gl} \cdot d_{eff} \cdot f_{ctd} = 266.032\ kN$

Armarea se face conf. SR EN 1992-1-1

$V_{Ed.GF} := 79\ kN$

$V_{Ed} := \max(V_{Ed.GF}, V_{Ed.max.GS}, V_{Ed.min.GS}) = 126.954\ kN$

$l_{cr} := h_{st} = 0.45\ m$

$\rho_l := \frac{A_{s.eff.rm}}{b_{gl} \cdot d} = 0.005$ <0.02

$C_{Rd.c} := 0.12$ $\eta := 1$ $k := 1 + \sqrt{\frac{200\ mm}{d_{eff}}} = 1.667$ <2

$$V_{Rd.c} := \left(C_{Rd.c} \cdot \eta \cdot k \cdot \left(100 \cdot \rho_l \cdot \frac{f_{ck}}{MPa}\right)^{\frac{1}{3}}\right) \cdot b_{gl} \cdot d \cdot MPa = 59.683\ kN$$

$$V_{Rd.c.min} := 0.035 \cdot k^{\frac{3}{2}} \cdot \left(\frac{f_{ck}}{MPa}\right)^{\frac{1}{2}} \cdot b_{gl} \cdot d \cdot MPa = 46.073\ kN$$

$\text{if}(V_{Ed} \geq V_{Rd.c}, \text{“armatura transv”}, \text{“nu”}) = \text{“armatura transv”}$

$a_{cw} := 1$ $\nu_1 := 0.6\left(1 - \frac{f_{ck}}{200\ MPa}\right) = 0.54$ $\theta := 21.8\ deg$ $\alpha_1 := 90\ deg$

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rc} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 306.044\ kN \qquad V_{Ed} = 126.954\ kN$$

$$ctg(\theta) := 1$$

Distanta dintre etrieri a.i. $V_{ed} < V_{Rds}$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2$$

$$s_v := \frac{A_{sw} \cdot z_{rc} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 14.157\ cm$$

Distanta maxima intre etrieri zona critica:

$$s_{max} := min\left(\frac{h_{gl}}{4}, 200\ mm, 8 \cdot 14\ mm\right) = 112\ mm$$ CLASA M

$$Aleg \qquad s := 10\ cm$$

Verificare procent de armatura la Ved $\alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gl} \cdot \sin(\alpha)} = 0.003 \qquad \rho_{w.cr.min} := 0.002$$

Verificarea cedarii ductile la Ved

$$\rho_{w.min} := \frac{0.08 \cdot \sqrt{25}}{434.783} = 9.2 \cdot 10^{-4}$$

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta) = 179.73\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

Dispunere etrieri dupa l.cr

$$V_{Ed} := 101\ kN$$

$$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$$

$$A_{sw} := 2 \cdot A_{\phi 8} = 100.6\ mm^2 \qquad ctg(\theta) := 1$$

$$s_v := \frac{A_{sw} \cdot z_{rm} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed}} = 17.795\ cm$$

$$V_{Rd.max} := \frac{a_{cw} \cdot z_{rm} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 306.044\ kN \quad V_{Ed} = 101\ kN$$

Calculul unghiului θ

$$ctg\theta := 2.5 - \left(\frac{\left(\left(V_{Ed} - V_{Rd.c} \right) \cdot 1.5 \right)}{V_{Rd.max} - V_{Rd.c}} \right) = 2.248$$

$$s_{max} := min\left(0.75 \cdot d_{eff}, 300\ mm\right) = 300\ mm$$

Aleg $s := 15\ cm$

Verificare procent de armatura la Ved $\alpha := 90\ deg$

$$\rho_w := \frac{A_{sw}}{s \cdot b_{gl} \cdot \sin(\alpha)} = 0.002 \qquad \rho_{w.min} := \frac{0.08 \cdot \sqrt{25}}{434.783} = 9.2 \cdot 10^{-4}$$

Verificarea cedarii ductile la Ved

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{rc} \cdot f_{yd} \cdot ctg(\theta) = 119.82\ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

Armare stalp

$\gamma_{Rd} := 1$ -clasa de ductilitate medie $\eta := 1$

$h_{st} = 0.45\ m$ $b_{st} = 0.45\ m$ -dimensiunile stalpului

$l_{cl.p} := h_{parter} = 4\ m$ -inaltimea libera a parterului

$l_{cl.e} := h_{etaj} = 3.2\ m$ -inaltimea libera a etajului

$l_{cr.p} := min\left(h_{st}, \frac{l_{cl.p}}{6}, 450\ mm\right) = 45\ cm$ $l_{cr} := 45\ cm$ -zona critică parter

$l_{cr.e} := min\left(h_{st}, \frac{l_{cl.e}}{6}, 450\ mm\right) = 45\ cm$ $l_{cr} := 45\ cm$ zona critică etaje

Stratul de acoperire cu beton

$c_{min.sl} := \max(20\ mm, 25\ mm, 10\ mm) = 25\ mm$

$c_{nom.sl} := 25\ mm + 10\ mm = 35\ mm$

$c_{nom.sw} := c_{nom.sl} - 8\ mm = 27\ mm$

$c_{nom} := 35\ mm$

conform cerintelor de rezistenta la foc =>

$\phi_{sw} := 8\ mm$ $\phi_{sl} := 20\ mm$ $\alpha_{eff} := c_{nom} + \phi_{sw} = 43\ mm$

$c_{nom} := 45\ mm$

$\alpha_{eff} := c_{nom} + \phi_{sw} = 53\ mm$ $\alpha_{min} := 53\ mm$

$\text{if}\left(\alpha_{eff} \leq \alpha_{min}, \text{“e bine”}, \text{“nue bine”}\right) = \text{“e bine”}$

Inaltimea utila stalp

$d := h_{st} - c_{nom} - \frac{\phi_{sl}}{2} = 395\ mm$

Distanța dintre armăturile pentru beton armat $f_{cd} = 13.333\ \frac{N}{mm^2}$

$s_{nh.min} := \max\left(\phi_{sl}, 16\ mm + 5\ mm, 250\ mm\right) = 250\ mm$

Dimensionarea armaturii longitudinale

$A_{s.min} := 0.008 \cdot h_{st} \cdot b_{st} = 16.2\ cm^2$ - procentul minim de armare

$A_{s.max} := \frac{4}{100} \cdot {h_{st}}^2 = 81\ cm^2$ - procentul maxim de armare

$A_{st} := h_{st} \cdot b_{st} = (2.025 \cdot 10^3)\ cm^2$ -aria secțiunii stalpului

$\rho_{l.min} := 0.008\%$ -procentul minim de armare $0.008 \cdot A_{st} = 16.2\ cm^2$

Aleg $8\phi 18$ $A_{s.eff} := 20.358\ cm^2$

A_{s1} =$3\phi 18$ $A_{s1} := 7.62\ cm^2$

A_{s2} =$3\phi 18$ $A_{s2} := 7.62\ cm^2$

$F_{s1.yd} := A_{s1} \cdot f_{yd} = 331.304\ kN$

$F_{s2.yd} := A_{s2} \cdot f_{yd} = 331.304\ kN$

$d_1 := c_{nom} + 10\ mm + \frac{18\ mm}{2} = 64\ mm$ $d_2 := c_{nom} + 10\ mm + \frac{18\ mm}{2} = 64\ mm$

$\varepsilon_{cu} := 0.0035$ $E_s := 200000\ \frac{N}{mm^2}$ $\varepsilon_{yd} := \frac{f_{yd}}{E_s} = 0.002$

$d := h_{st} - d_1 = 386\ mm$ $\lambda := 0.8$ $\eta := 1$

$z_{s1} := \frac{h_{st}}{2} - d_1 = 0.161\ m$ $z_{s2} := \frac{h_{st}}{2} - d_2 = 0.161\ m$

$N_{Rd.2a1} := F_{s1.yd} + F_{s2.yd} - b_{st} \cdot \lambda \cdot \left(\frac{\varepsilon_{cu} \cdot d_2}{\varepsilon_{cu} + \varepsilon_{yd}}\right) \cdot \eta \cdot f_{cd} = 473.11\ kN$

$N_{Rd.2a2} := F_{s1.yd} - F_{s2.yd} - b_{st} \cdot \lambda \cdot \left(\frac{\varepsilon_{cu} \cdot d_2}{\varepsilon_{cu} - \varepsilon_{yd}}\right) \cdot \eta \cdot f_{cd} = -810.807\ kN$

$N_{Rd.2b} := F_{s1.yd} - F_{s2.yd} - b_{st} \cdot \lambda \cdot \left(\frac{\varepsilon_{cu} \cdot d}{\varepsilon_{cu} + \varepsilon_{yd}}\right) \cdot \eta \cdot f_{cd} = -1.143 \cdot 10^3\ kN$

$N_{Rd.2c} := -F_{s2.yd} - b_{st} \cdot \lambda \cdot d \cdot \eta \cdot f_{cd} = -2.184 \cdot 10^3\ kN$

GF11 $N_{Ed} := -1627\ kN$ $M_{Ed.y} := 118.3\ kN \cdot m$ $M_{Ed.z} := 3.85\ kN \cdot m$

$N_{ext} := N_{Ed} = -1.627 \cdot 10^3\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 1$ 2b

$$M_{Rd.2a1} := F_{s1.yd} \cdot z_{s1} - F_{s2.yd} \cdot z_{s2} + \frac{1}{2} \cdot \left(b_{st} \cdot \lambda \cdot \frac{\varepsilon_{cu} \cdot d_2}{\varepsilon_{cu} + \varepsilon_{yd}} \cdot \eta \cdot f_{cd} \right) \cdot \left(h_{st} - \frac{\lambda \cdot \varepsilon_{cu} \cdot d_2}{\varepsilon_{cu} + \varepsilon_{yd}} \right) = 39.645\ kN \cdot m$$

$$M_{Rd.2a2} := F_{s1.yd} \cdot z_{s1} + F_{s2.yd} \cdot z_{s2} + \frac{1}{2} \cdot \left(b_{st} \cdot \lambda \cdot \frac{\varepsilon_{cu} \cdot d_2}{\varepsilon_{cu} - \varepsilon_{yd}} \cdot \eta \cdot f_{cd} \right) \cdot \left(h_{st} - \frac{\lambda \cdot \varepsilon_{cu} \cdot d_2}{\varepsilon_{cu} - \varepsilon_{yd}} \right) = 234.328\ kN \cdot m$$

$$M_{Rd.2b} := F_{s1.yd} \cdot z_{s1} + F_{s2.yd} \cdot z_{s2} + \frac{1}{2} \cdot \left(b_{st} \cdot \lambda \cdot \frac{\varepsilon_{cu} \cdot d}{\varepsilon_{cu} + \varepsilon_{yd}} \cdot \eta \cdot f_{cd} \right) \cdot \left(h_{st} - \frac{\lambda \cdot \varepsilon_{cu} \cdot d}{\varepsilon_{cu} + \varepsilon_{yd}} \right) = 254.981\ kN \cdot m$$

$$M_{Rd.2c} := F_{s2.yd} \cdot z_{s2} + \frac{1}{2} \cdot \left(b_{st} \cdot \lambda \cdot d \cdot \eta \cdot f_{cd} \right) \left(h_{st} - \lambda \cdot d \right) = 184.148\ kN \cdot m$$

Domeniul de solicitare 2b

$$M_{Rdy} := \left(N_{ext} - N_{Rd.2b} \right) \cdot \left(\frac{M_{Rd.2c} - M_{Rd.2b}}{N_{Rd.2c} - N_{Rd.2b}} \right) + M_{Rd.2b} = 222.048\ kN \cdot m$$

$M_{Rdz} := M_{Rdy}$

$A_c := A_{st} = \left(2.025 \cdot 10^3 \right)\ cm^2$ $A_{stot} := A_{s.eff} = 20.358\ cm^2$

$N_{Rd} := A_c \cdot f_{cd} + A_{stot} \cdot f_{yd} = \left(3.585 \cdot 10^3 \right)\ kN$ $N_{min} := A_{stot} \cdot f_{yd} = 885.13\ kN$

$\frac{N_{Ed}}{N_{Rd}} = -0.454$ $\alpha := 1.295$ $\left(\frac{M_{Ed.y}}{M_{Rdy}} \right)^{\alpha} + \left(\frac{M_{Ed.z}}{M_{Rdz}} \right)^{\alpha} = 0.448 < 1$

GF12 $N_{Ed} := -1616\ kN$ $M_{Ed.y} := 10.67\ kN \cdot m$ $M_{Ed.z} := 3.88\ kN \cdot m$

$N_{ext} := N_{Ed} = -1.616 \cdot 10^3\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 1$ 2b

Domeniul de solicitare 2b

$$M_{Rdy} := (N_{ext} - N_{Rd.2b}) \cdot \left(\frac{M_{Rd.2c} - M_{Rd.2b}}{N_{Rd.2c} - N_{Rd.2b}} \right) + M_{Rd.2b} = 222.797 \ kN \cdot m$$

$$M_{Rdz} := M_{Rdy}$$

$$A_c := A_{st} = \left(2.025 \cdot 10^3\right) \ cm^2 \qquad A_{stot} := A_{s.eff} = 20.358 \ cm^2$$

$$N_{Rd} := A_c \cdot f_{cd} + A_{stot} \cdot f_{yd} = \left(3.585 \cdot 10^3\right) \ kN \qquad N_{min} := A_{stot} \cdot f_{yd} = 885.13 \ kN$$

$$\frac{N_{Ed}}{N_{Rd}} = -0.451 \qquad \alpha := 1.293 \qquad \left(\frac{M_{Ed.y}}{M_{Rdy}} \right)^{\alpha} + \left(\frac{M_{Ed.z}}{M_{Rdz}} \right)^{\alpha} = 0.025 < 1$$

GF10 $\qquad N_{Ed} := -1579 \ kN \qquad M_{Ed.y} := 129 \ kN \cdot m \qquad M_{Ed.z} := 3.84 \ kN \cdot m$

$$N_{ext} := N_{Ed} = -1.579 \cdot 10^3 \ kN$$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 1$ 2b

Domeniul de solicitare 2b

$$M_{Rdy} := (N_{ext} - N_{Rd.2b}) \cdot \left(\frac{M_{Rd.2c} - M_{Rd.2b}}{N_{Rd.2c} - N_{Rd.2b}} \right) + M_{Rd.2b} = 225.314 \ kN \cdot m$$

$$M_{Rdz} := M_{Rdy}$$

$$A_c := A_{st} = \left(2.025 \cdot 10^3\right) \ cm^2 \qquad A_{stot} := A_{s.eff} = 20.358 \ cm^2$$

$$N_{Rd} := A_c \cdot f_{cd} + A_{stot} \cdot f_{yd} = \left(3.585 \cdot 10^3\right) \ kN \qquad N_{min} := A_{stot} \cdot f_{yd} = 885.13 \ kN$$

$$\frac{N_{Ed}}{N_{Rd}} = -0.44 \qquad \alpha := 1.29 \qquad \left(\frac{M_{Ed.y}}{M_{Rdy}} \right)^{\alpha} + \left(\frac{M_{Ed.z}}{M_{Rdz}} \right)^{\alpha} = 0.492 < 1$$

GF 7 $\qquad N_{Ed} := -1486 \ kN \qquad M_{Ed.y} := 0.2 \ kN \cdot m \qquad M_{Ed.z} := 43 \ kN \cdot m$

$$N_{ext} := N_{Ed} = -1.486 \cdot 10^3 \ kN$$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 1$ 2b

Domeniul de solicitare 2b

$$M_{Rdy} := \left(N_{ext} - N_{Rd.2b}\right) \cdot \left(\frac{M_{Rd.2c} - M_{Rd.2b}}{N_{Rd.2c} - N_{Rd.2b}}\right) + M_{Rd.2b} = 231.641 \ kN \cdot m$$

$$M_{Rdz} := M_{Rdy}$$

$$A_c := A_{st} = \left(2.025 \cdot 10^3\right) \ cm^2 \qquad A_{stot} := A_{s.eff} = 20.358 \ cm^2$$

$$N_{Rd} := A_c \cdot f_{cd} + A_{stot} \cdot f_{yd} = \left(3.585 \cdot 10^3\right) \ kN \qquad N_{min} := A_{stot} \cdot f_{yd} = 885.13 \ kN$$

$$\frac{N_{Ed}}{N_{Rd}} = -0.414 \qquad \alpha := 1.2 \qquad \left(\frac{M_{Ed.y}}{M_{Rdy}}\right)^{\alpha} + \left(\frac{M_{Ed.z}}{M_{Rdz}}\right)^{\alpha} = 0.133 < 1$$

GF 6 $\qquad N_{Ed} := -1486 \ kN \qquad M_{Ed.y} := 0.2 \ kN \cdot m \qquad M_{Ed.z} := 43 \ kN \cdot m$

$$N_{ext} := N_{Ed} = -1.486 \cdot 10^3 \ kN$$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 1$ 2b

Domeniul de solicitare 2b

$$M_{Rdy} := \left(N_{ext} - N_{Rd.2b}\right) \cdot \left(\frac{M_{Rd.2c} - M_{Rd.2b}}{N_{Rd.2c} - N_{Rd.2b}}\right) + M_{Rd.2b} = 231.641 \ kN \cdot m$$

$$M_{Rdz} := M_{Rdy}$$

$$A_c := A_{st} = \left(2.025 \cdot 10^3\right) \ cm^2 \qquad A_{stot} := A_{s.eff} = 20.358 \ cm^2$$

$$N_{Rd} := A_c \cdot f_{cd} + A_{stot} \cdot f_{yd} = \left(3.585 \cdot 10^3\right) \ kN \qquad N_{min} := A_{stot} \cdot f_{yd} = 885.13 \ kN$$

$$\frac{N_{Ed}}{N_{Rd}} = -0.414 \qquad \alpha := 1.26 \qquad \left(\frac{M_{Ed.y}}{M_{Rdy}}\right)^{\alpha} + \left(\frac{M_{Ed.z}}{M_{Rdz}}\right)^{\alpha} = 0.12 < 1$$

INF GF $\qquad N_{Ed} := -1728 \ kN \qquad M_{Ed.y} := 61 \ kN \cdot m \qquad M_{Ed.z} := 129 \ kN \cdot m$

$$N_{ext} := N_{Ed} = -1.728 \cdot 10^3 \ kN$$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 1$ 2b

Domeniul de solicitare 2b

$$M_{Rdy} := \left(N_{ext} - N_{Rd.2b}\right) \cdot \left(\frac{M_{Rd.2c} - M_{Rd.2b}}{N_{Rd.2c} - N_{Rd.2b}}\right) + M_{Rd.2b} = 215.177 \ kN \cdot m$$

$$M_{Rdz} := M_{Rdy}$$

$$A_c := A_{st} = \left(2.025 \cdot 10^3\right) \ cm^2 \qquad A_{stot} := A_{s.eff} = 20.358 \ cm^2$$

$$N_{Rd} := A_c \cdot f_{cd} + A_{stot} \cdot f_{yd} = \left(3.585 \cdot 10^3\right) \ kN \qquad N_{min} := A_{stot} \cdot f_{yd} = 885.13 \ kN$$

$$\frac{N_{Ed}}{N_{Rd}} = -0.482 \qquad \alpha := 1.31 \qquad \left(\frac{M_{Ed.y}}{M_{Rdy}}\right)^{\alpha} + \left(\frac{M_{Ed.z}}{M_{Rdz}}\right)^{\alpha} = 0.703 < 1$$

Momentul incovoietor pe inaltimea stalpului nu depaseste capacitatea portanta la incovoiere pura pe inaltimea stalpului

GS $N_{Ed} := -1012\ kN$ $M_{Ed.y} := 70.13\ kN \cdot m$ $M_{Ed.z} := 68.57\ kN \cdot m$

$N_{ext} := N_{Ed} = -1.012 \cdot 10^3\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a"
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 1$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

$N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c}$ => **Domeniul de solicitare 2a'''**

$$\lambda x_c := \frac{F_{s1.yd} - F_{s2.yd} - N_{ext}}{b_{st} \cdot \eta \cdot f_{cd}} = 0.169\ m$$

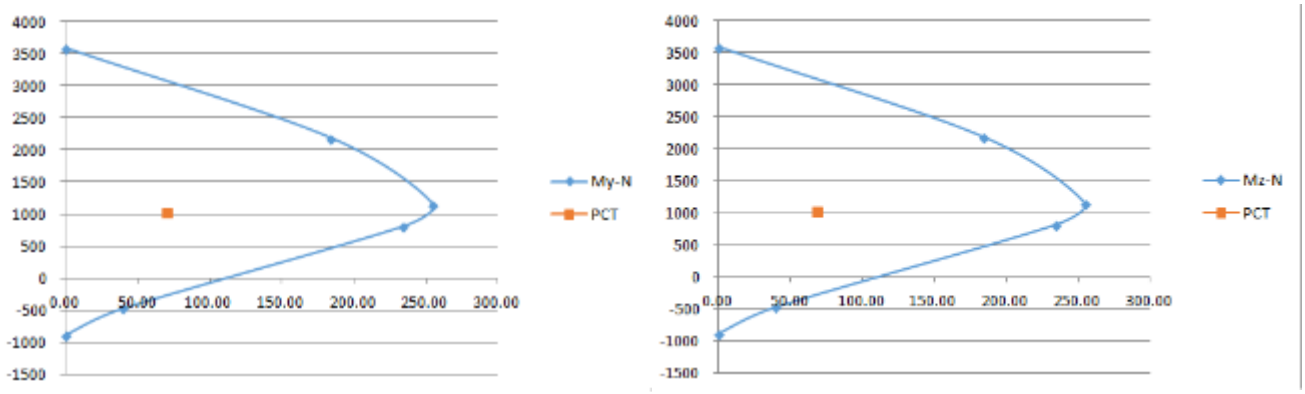
$$M_{Rdy} := F_{s1.yd} \cdot z_{s1} + F_{s2.yd} \cdot z_{s2} + \left(F_{s1.yd} - F_{s2.yd} - N_{ext}\right) \cdot \left(\frac{h_{st} - \lambda x_c}{2}\right) = 249.035\ kN \cdot m$$

$M_{Rdz} := M_{Rdy}$

$A_c := A_{st} = \left(2.025 \cdot 10^3\right)\ cm^2$ $A_{stot} := A_{s.eff} = 20.358\ cm^2$

$N_{Rd} := A_c \cdot f_{cd} + A_{stot} \cdot f_{yd} = \left(3.585 \cdot 10^3\right)\ kN$ $N_{min} := A_{stot} \cdot f_{yd} = 885.13\ kN$

$$\frac{N_{Ed}}{N_{Rd}} = -0.282 \quad \alpha := 1.15 \quad \left(\frac{M_{Ed.y}}{M_{Rdy}}\right)^{\alpha} + \left(\frac{M_{Ed.z}}{M_{Rdz}}\right)^{\alpha} = 0.46 < 1$$



Verificarea nodului grinda stalp:

Suma momentelor capabile pe stalp

Momentul capabil va vi acelasi pe ambele directii pentru ca sectunea stalpului este simetrica

-momentul capabil al stalpului la partea superioara a nodului

$N_{Ed} := -611\ kN$

$N_{ext} := N_{Ed} = -611\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a''

$$M_{Rdy} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 204.03\ kN \cdot m$$
$$M_{Rdz} := M_{Rdy}$$

$M_{cap.st.1} := M_{Rdy}$

-momentul capabil al stalpului la partea inferioara a nodului

$N_{Ed} := -808.42\ kN$

$N_{ext} := N_{Ed} = -808.42\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a''

$$M_{Rdy} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 233.966\ kN \cdot m$$
$$M_{Rdz} := M_{Rdy}$$

$M_{cap.st.2} := M_{Rdy}$

Suma momentelor capabile pe grinzi:

Grinda transversala:

$M_{Rd.rc.tr} = 126.847\ kN \cdot m$

$M_{Rd.c.tr} = 88.785\ kN \cdot m$

$\Sigma M_{cap.gr.tr} := M_{Rd.rc.tr} + M_{Rd.c.tr} = 215.632\ kN \cdot m$

Armarea fiind simetrica vom avea acelasi moment capabil si pe cealalta directie

Grinda longitudinala:

$M_{Rd.rc.lg} = 138.338\ kN \cdot m$

$M_{Rd.c.lg} = 107.676\ kN \cdot m$

$\Sigma M_{cap.gr.lg} := M_{Rd.rc.lg} + M_{Rd.c.lg} = 246.014\ kN \cdot m$

Armarea fiind simetrica vom avea acelasi moment capabil si pe cealalta directie

$\Sigma M_{cap.gr.tr} \le M_{cap.st.1} + M_{cap.st.2} = 1$

$\Sigma M_{cap.gr.lg} \le M_{cap.st.1} + M_{cap.st.2} = 1$

Este indeplinita conditia de rigiditate a nodului.

Verificarea la forta taietoare:

Calculul momentelor capabile din gruparea seismica:

parter $N_{Ed} := -1058\ kN$ $N_{ext} := N_{Ed} = -1.058 \cdot 10^3\ kN$

- $N_{Rd.2a1} \ge N_{ext} \ge N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \ge N_{ext} \ge N_{Rd.2b} = 1$ 2a'''
- $N_{Rd.2b} \ge N_{ext} \ge N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a'''

$$\lambda x_c := \frac{F_{s1.yd} - F_{s2.yd} - N_{ext}}{b_{st} \cdot \eta \cdot f_{cd}} = 0.176\ m$$

$$M_{Rdy.p1} := F_{s1.yd} \cdot z_{s1} + F_{s2.yd} \cdot z_{s2} + \left(F_{s1.yd} - F_{s2.yd} - N_{ext}\right) \cdot \left(\frac{h_{st} - \lambda x_c}{2}\right) = 251.45\ kN \cdot m$$

$M_{Rdz.p1} := M_{Rdy.p1}$

$N_{Ed} := -1012\ kN$ $N_{ext} := N_{Ed} = -1.012 \cdot 10^3\ kN$

- $N_{Rd.2a1} \ge N_{ext} \ge N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \ge N_{ext} \ge N_{Rd.2b} = 1$ 2a'''
- $N_{Rd.2b} \ge N_{ext} \ge N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a'''

$$\lambda x_c := \frac{F_{s1.yd} - F_{s2.yd} - N_{ext}}{b_{st} \cdot \eta \cdot f_{cd}} = 0.169\ m$$

$$M_{Rdy.p2} := F_{s1.yd} \cdot z_{s1} + F_{s2.yd} \cdot z_{s2} + \left(F_{s1.yd} - F_{s2.yd} - N_{ext}\right) \cdot \left(\frac{h_{st} - \lambda x_c}{2}\right) = 249.035\ kN \cdot m$$

$$M_{Rdz.p2} := M_{Rdy.p2}$$

etaj 1 $N_{Ed} := -837\ kN$ $N_{ext} := N_{Ed} = -837\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 0$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 1$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a'''

$$\lambda x_c := \frac{F_{s1.yd} - F_{s2.yd} - N_{ext}}{b_{st} \cdot \eta \cdot f_{cd}} = 0.14\ m$$

$$M_{Rdy.e11} := F_{s1.yd} \cdot z_{s1} + F_{s2.yd} \cdot z_{s2} + \left(F_{s1.yd} - F_{s2.yd} - N_{ext}\right) \cdot \left(\frac{h_{st} - \lambda x_c}{2}\right) = 236.624\ kN \cdot m$$

$$M_{Rdz.e11} := M_{Rdy.p2}$$

$N_{Ed} := -808\ kN$ $N_{ext} := N_{Ed} = -808\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a'''

$$M_{Rdy.e12} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 233.902\ kN \cdot m$$

$$M_{Rdz.e12} := M_{Rdy.e12}$$

etaj 2 $N_{Ed} := -628\ kN$ $N_{ext} := N_{Ed} = -628\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a''

$$M_{Rdy.e21} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 206.608\ kN \cdot m$$

$$M_{Rdz.e21} := M_{Rdy.e21}$$

$N_{Ed} := -611\ kN$ $N_{ext} := N_{Ed} = -611\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a''

$$M_{Rdy.e22} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 204.03\ kN \cdot m$$
$$M_{Rdz.e22} := M_{Rdy.e22}$$

etaj 3 $N_{Ed} := -423\ kN$ $N_{ext} := N_{Ed} = -423\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

Domeniul de solicitare 2a''

$$M_{Rdy.e31} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 175.524\ kN \cdot m$$
$$M_{Rdz.e31} := M_{Rdy.e31}$$

$-414\ kN$ $N_{ext} := N_{Ed} = -414\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

$N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c}$ => **Domeniul de solicitare 2a''**

$$M_{Rdy.e32} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 174.159\ kN \cdot m$$
$$M_{Rdz.e32} := M_{Rdy.e32}$$

etaj 4 $N_{Ed} := -222\ kN$ $N_{ext} := N_{Ed} = -222\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

$N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c}$ => **Domeniul de solicitare 2a''**

$$M_{Rdy.e41} := \left(N_{ext} - N_{Rd.2a1}\right) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}}\right) + M_{Rd.2a1} = 145.046\ kN \cdot m$$
$$M_{Rdz.e41} := M_{Rdy.e41}$$

$N_{Ed} := -220\ kN \qquad N_{ext} := N_{Ed} = -220\ kN$

- $N_{Rd.2a1} \geq N_{ext} \geq N_{Rd.2a2} = 1$ 2a''
- $N_{Rd.2a2} \geq N_{ext} \geq N_{Rd.2b} = 0$ 2a'''
- $N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c} = 0$ 2b

$N_{Rd.2b} \geq N_{ext} \geq N_{Rd.2c}$ => **Domeniul de solicitare 2a''**

$$M_{Rdy.e42} := (N_{ext} - N_{Rd.2a1}) \cdot \left(\frac{M_{Rd.2a2} - M_{Rd.2a1}}{N_{Rd.2a2} - N_{Rd.2a1}} \right) + M_{Rd.2a1} = 144.742\ kN \cdot m$$
$$M_{Rdz.e42} := M_{Rdy.e42}$$

Calculul fortelor taietoare la capete de stalpi datorate seismului

$\gamma_{Rd} := 1$ DCM (factor de suprarezistenta din consolidarea otelului)

$$V_{Ed.S.p} := \gamma_{Rd} \cdot \frac{M_{Rdy.p1} + M_{Rdy.p2}}{h_{parter}} = 125.121\ kN \qquad h_{parter} = 4\ m$$

$V_{Ed.GF.p} := 48\ kN$

$V_{Ed.p} := \max(V_{Ed.S.p}, V_{Ed.GF.p}) = 125.121\ kN$

$$V_{Ed.S.e1} := \gamma_{Rd} \cdot \frac{M_{Rdy.e11} + M_{Rdy.e12}}{h_{etaj}} = 147.039\ kN \qquad h_{etaj1} := h_{etaj} = 3.2\ m$$

$V_{Ed.GF.e1} := 49\ kN$

$V_{Ed.e1} := \max(V_{Ed.S.e1}, V_{Ed.GF.e1}) = 147.039\ kN$

$$V_{Ed.S.e2} := \gamma_{Rd} \cdot \frac{M_{Rdy.e21} + M_{Rdy.e22}}{h_{etaj}} = 128.325\ kN \qquad h_{etaj2} := h_{etaj} = 3.2\ m$$

$V_{Ed.GF.e2} := 37\ kN$

$V_{Ed.e2} := \max(V_{Ed.S.e2}, V_{Ed.GF.e2}) = 128.325\ kN$

$$V_{Ed.S.e3} := \gamma_{Rd} \cdot \frac{M_{Rdy.e31} + M_{Rdy.e32}}{h_{etaj}} = 109.276\ kN \qquad h_{etaj3} := h_{etaj} = 3.2\ m$$

$V_{Ed.GF.e3} := 25\ kN$

$V_{Ed.e3} := \max(V_{Ed.S.e3}, V_{Ed.GF.e3}) = 109.276\ kN$

$$V_{Ed.S.e4} := \gamma_{Rd} \cdot \frac{M_{Rdy.e41} + M_{Rdy.e42}}{h_{etaj}} = 90.559\ kN \qquad h_{etaj4} := h_{etaj} = 3.2\ m$$

$V_{Ed.GF.e4} := 16.35\ kN$

$V_{Ed.e4} := \max(V_{Ed.S.e4}, V_{Ed.GF.e4}) = 90.559\ kN$

Calculul armaturilor la forta taietoare:

Parter: $V_{Ed.p} = 125.121\ kN$

Prevederi constructive:

$0.25 \cdot 18\ mm = 4.5\ mm$ diametru minim conditia de stalp scurt

$l_{cr.p} := 1.5 \cdot \max\left(h_{st}, \frac{h_{parter}}{6}, 450\ mm\right) = 1\ m$ parter $l_{cr.p} \geq \frac{h_{parter}}{3} = 0$

$l_{cr} := \max\left(h_{st}, \frac{h_{etaj}}{6}, 450\ mm\right) = 0.533\ m$ etaj

Distanta maxima inte etrieri in afara zonei critice

$s_{max} := min\left(15 \cdot 18\ mm, h_{st}, 300\ mm\right) = 270\ mm$

$d_{st} := h_{st} - c_{nom} - 8\ mm - \frac{18\ mm}{2} = 0.388\ m$ $z_{st} := 0.9\ d_{st} = 0.349\ m$

$\rho_l := \frac{A_{s1}}{b_{st} \cdot d_{st}} = 0.004$ <0.02

$C_{Rd.c} := 0.12$ $\eta := 1$ $k := 1 + \sqrt{\frac{200\ mm}{d_{st}}} = 1.718$ <2

$V_{Rd.c} := \left(C_{Rd.c} \cdot \eta \cdot k \cdot \left(100 \cdot \rho_l \cdot \frac{f_{ck}}{MPa}\right)^{\frac{1}{3}}\right) \cdot b_{st} \cdot d_{st} \cdot MPa = 74.111\ kN$

$V_{Rd.c.min} := 0.035 \cdot k^{\frac{3}{2}} \cdot \left(\frac{f_{ck}}{MPa}\right)^{\frac{1}{2}} \cdot b_{st} \cdot d_{st} \cdot MPa = 61.538\ kN$

$\text{if}\left(V_{Ed} \geq V_{Rd.c}, \text{“armatura transv”}, \text{“nu”}\right) = \text{“armatura transv”}$

$a_{cw} := 1$ $\nu_1 := 0.6\left(1 - \frac{f_{ck}}{200\ MPa}\right) = 0.54$ $\theta := 21.8\ deg$ $\alpha_1 := 90\ deg$

$V_{Rd.max} := \frac{a_{cw} \cdot z_{rc} \cdot b_{gl} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 306.044\ kN$

$ctg(\theta) := 1$

Distanta dintre etrieri a.i. $V_{ed} < V_{Rds}$

$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$

$A_{sw} := 4 \cdot A_{\phi 8} = 201.2\ mm^2$

$s_v := \frac{A_{sw} \cdot z_{st} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed.p}} = 24.414\ cm$

Distanta maxima intre etrieri zona critica:

$b_0 := h_{st} - 2 \cdot c_{nom} = 0.36\ m \qquad s_{max} := min\left(\frac{b_0}{2}, 175\ mm, 8 \cdot 18\ mm\right) = 144\ mm$

$Aleg \qquad s := 10\ cm$

Verificare procent de armatura la Ved

$A_{sw.min} := \frac{4 \cdot A_{\phi 8}}{h_{st} \cdot s} \cdot 100 = 0.447 \qquad > \qquad \rho_{w.cr.min} := 0.35\%$

Verificarea cedarii ductile la Ved

$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{st} \cdot f_{yd} \cdot ctg(\theta) = 305.474\ kN$

$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed.p} = 1$

Etaj 1: $V_{Ed.e1} = 147.039\ kN$

Prevederi constructive:

$0.25 \cdot 18\ mm = 4.5\ mm$ diametru minim conditia de stalp scurt

$l_{cr.p} := 1.5 \cdot \max\left(h_{st}, \frac{h_{parter}}{6}, 450\ mm\right) = 1\ m$ parter $l_{cr.p} \geq \frac{h_{parter}}{3} = 0$

$l_{cr} := \max\left(h_{st}, \frac{h_{parter}}{6}, 450\ mm\right) = 0.667\ m$ etaj

Distanta maxima inte etrieri in afara zonei critice

$s_{max} := min\left(15 \cdot 18\ mm, h_{st}, 300\ mm\right) = 270\ mm$ Aleg 250mm

$d_{st} := h_{st} - c_{nom} - 8\ mm - \frac{18\ mm}{2} = 0.388\ m \qquad z_{st} := 0.9\ d_{st} = 0.349\ m$

$\rho_l := \frac{A_{s1}}{b_{st} \cdot d_{st}} = 0.004 \qquad < 0.02$

$C_{Rd.c} := 0.12 \qquad \eta := 1 \qquad k := 1 + \sqrt{\frac{200\ mm}{d_{st}}} = 1.718 \qquad < 2$

$V_{Rd.c} := \left(C_{Rd.c} \cdot \eta \cdot k \cdot \left(100 \cdot \rho_l \cdot \frac{f_{ck}}{MPa} \right)^{\frac{1}{3}} \right) \cdot b_{st} \cdot d_{st} \cdot MPa = 74.111\ kN$

$V_{Rd.c.min} := 0.035 \cdot k^{\frac{3}{2}} \cdot \left(\frac{f_{ck}}{MPa} \right)^{\frac{1}{2}} \cdot b_{st} \cdot d_{st} \cdot MPa = 61.538\ kN$

$\text{if}\left(V_{Ed} \geq V_{Rd.c}, \text{“armatura transv”}, \text{“nu”} \right) = \text{“armatura transv”}$

$a_{cw} := 1 \qquad \nu_1 := 0.6 \left(1 - \frac{f_{ck}}{200\ MPa} \right) = 0.54 \qquad \theta := 21.8\ deg \qquad \alpha_1 := 90\ deg$

$V_{Rd.max} := \frac{a_{cw} \cdot z_{rc} \cdot b_{gt} \cdot f_{cd} \cdot \nu_1}{\cot(\theta) + \tan(\theta)} = 306.044\ kN$

$ctg(\theta) := 1$

Distanta dintre etrieri a.i. $V_{ed} < V_{Rds} \qquad h_{etaj} = 3.2\ m$

$\phi_w := 8\ mm \qquad A_{\phi 8} := 50.3\ mm^2 = 0.503\ cm^2$

$A_{sw} := 4 \cdot A_{\phi 8} = 201.2\ mm^2$

$s_v := \frac{A_{sw} \cdot z_{st} \cdot f_{yd} \cdot ctg(\theta)}{V_{Ed.p}} = 24.414\ cm$

Distanta maxima intre etrieri zona critica:

$b_0 := h_{st} - 2 \cdot c_{nom} = 0.36\ m \qquad s_{max} := min\left(\frac{b_0}{2}, 175\ mm, 8 \cdot 18\ mm \right) = 144\ mm$

$Aleg \qquad s := 10\ cm$

Verificare procent de armatura la Ved

$$A_{sw.min} := \frac{4 \cdot A_{\phi 8}}{h_{st} \cdot s} \cdot 100 = 0.447 \qquad > \qquad \rho_{w.cr.min} := 0.35\%$$

Verificarea cedarii ductile la Ved

$$V_{Rds} := \frac{A_{sw}}{s} \cdot z_{st} \cdot f_{yd} \cdot ctg(\theta) = 305.474 \ kN$$

$$V_{Rds} < V_{Rd.max} = 1 \qquad V_{Rds} > V_{Ed} = 1$$

Lungimi de ancoraj:

$$l_{bd.rqd} := 124 \ cm \quad \alpha_1 := 1 \quad \phi := 18 \ mm \quad c_d := min\left(\frac{250}{2} \ mm, c_{nom}\right) = 4.5 \ cm$$

$$\alpha_2 := 1 - 0.15 \frac{(c_d - \phi)}{\phi} = 0.775$$

$$K := 0.05 \quad \lambda := 1 \quad \alpha_3 := 1 - K \cdot \lambda = 0.95$$

$$\alpha_4 := 0.7$$

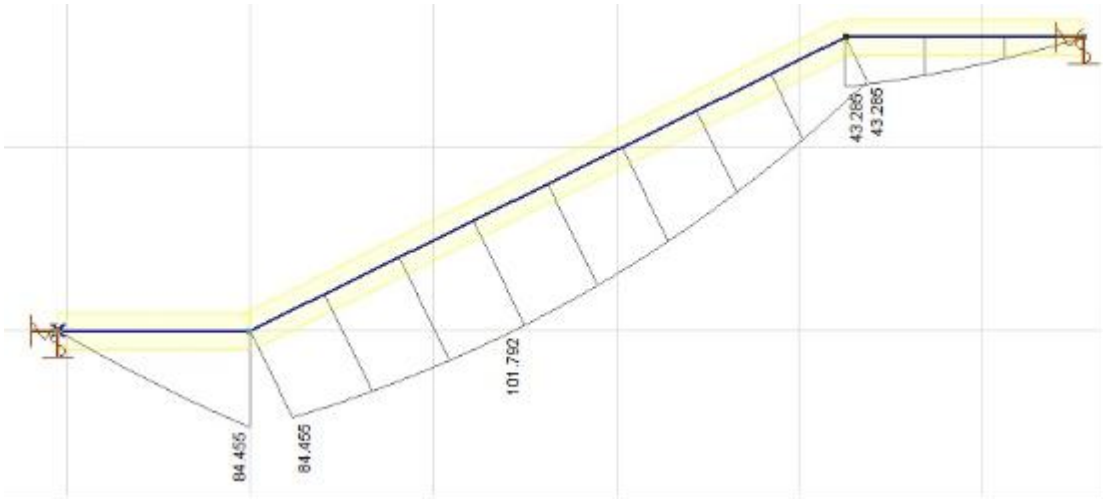
$$\alpha_5 := 1$$

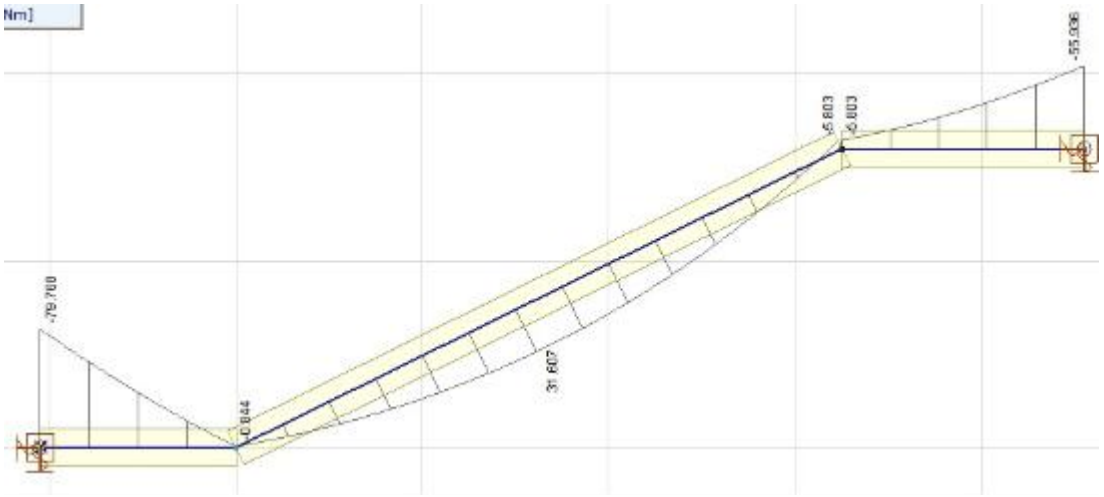
$$l_{bd} := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{bd.rqd} = 63.907 \ cm$$ Aleg lbd=70cm

$$\alpha_6 := 1.5$$

$$l_0 := \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot \alpha_6 \cdot l_{bd.rqd} = 95.86 \ cm$$ Aleg l0=80cm

Armare rampa de scara:





$$h_{p.s} := \frac{t_1}{25} = 0.182\ m \qquad h_{p.s} := 20\ cm$$

Aleg h=20cm

<u>incarcare pe placa:</u>

greutate trepre $g_{tr} := \frac{16\ cm}{2} \cdot 1.2\ m \cdot 25\ \frac{kN}{m^3} = 2.4\ \frac{kN}{m}$

$$g_k := g_{tr} + h_{p.s} \cdot 25\ \frac{kN}{m^3} \cdot 1.2\ m + g_{k.pr} \cdot 1.2\ m = 14.764\ \frac{kN}{m}$$

$$q_k := 1.2\ m \cdot \max\left(3\ \frac{kN}{m^2}, q_n\right) = 3.6\ \frac{kN}{m}$$

Momente de calcul

$M_c := 101.72\ kN \cdot m$

$M_r := 80\ kN \cdot m$

$h_p := 0.2\ m$

$b := 1\ m$

$d := h_p - c_{nom} - \frac{8\ mm}{2} = 15.1\ cm$

$M_{Ed} := M_r = 80\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.263 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.312$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 14.435\ cm^2$ => aleg $\phi 10/50$ mm $A_{ef.1.x} := 16.5\ cm^2$

$M_{Ed} := M_c = 101.72\ kN \cdot m$

$\mu_{cc.eff} := \frac{M_{Ed}}{f_{cd} \cdot b \cdot d^2} = 0.335 \qquad \omega_{eff} := 1 - \sqrt{(1 - 2 \cdot \mu_{cc.eff})} = 0.425$

$A_{nec.1.x} := \omega_{eff} \cdot d \cdot b \cdot \frac{f_{cd}}{f_{yd}} = 19.673\ cm^2$ => aleg $\phi 12/50$ mm $A_{ef.1.x} := 23.7\ cm^2$