

پیوست

منتخب مشخصات

نیبروخ‌های ساختمانی

طراحی کاربردی سازه‌های فولادی - محسن گرامی

نیمرخ IPE

IPE	bf	tf	d	tw	r	K	d-2K	G	A	I _x	S _x	r _x	Z _x	I _y	S _y	r _y	Z _y	J	Lp	Lr	a ₁	r _t	Kc	Cw	r _{ts}	√ECw/GJ
units	cm	cm	cm	cm	cm	cm	cm	kg/m	cm ²	cm ⁴	cm ³	cm	cm ³	cm ⁴	cm ³	cm	cm ³	cm ⁴	cm	cm	mm	cm		cm ⁶	cm	cm
8	4.6	0.52	8	0.38	0.5	1.02	5.9	6.0	7.64	80.1	20.0	3.24	22.5	8.5	3.69	1.05	5.75	0.56	53.9	267.5	63.0	1.22	0.76	118.8	1.26	23.5
10	5.5	0.57	10	0.41	0.7	1.27	7.4	8.1	10.3	171	34.2	4.07	37.6	15.9	5.79	1.24	8.99	0.88	63.6	276.3	79.0	1.46	0.76	353.5	1.48	32.3
12	6.4	0.63	12	0.44	0.7	1.33	9.3	10.4	13.2	318	53.0	4.90	58.5	27.7	8.65	1.45	13.42	1.37	74.4	300.0	96.0	1.69	0.76	895.2	1.72	41.2
14	7.3	0.69	14	0.47	0.7	1.39	11.2	12.9	16.4	541	77.3	5.74	85.8	44.9	12.3	1.65	19.08	2.04	84.7	325.7	112	1.93	0.76	1988.6	1.97	50.4
16	8.2	0.74	16	0.50	0.9	1.64	12.7	15.8	20.1	869	109	6.58	119.0	68.3	16.7	1.84	25.79	2.82	94.4	344.5	129	2.17	0.74	3976.2	2.19	60.5
18	9.1	0.80	18	0.53	0.9	1.70	14.6	18.8	23.9	1320	146	7.42	160.9	101	22.2	2.06	34.28	3.92	105.7	374.8	145	2.40	0.72	7470.0	2.44	70.4
20	10	0.85	20	0.56	1.2	2.05	15.9	22.4	28.5	1940	194	8.26	209.7	142	28.5	2.24	43.93	5.17	114.9	393.6	162	2.64	0.70	13019	2.65	80.9
22	11	0.92	22	0.59	1.2	2.12	17.7	26.2	33.4	2770	252	9.11	273.3	205	37.3	2.48	57.41	7.09	127.3	430.7	179	2.91	0.68	22774	2.93	91.4
24	12	0.98	24	0.62	1.5	2.48	19.0	30.7	39.1	3890	324	9.97	346.0	284	47.3	2.60	72.68	9.28	133.4	458.8	196	3.18	0.67	37624	3.18	102.7
27	13.5	1.02	27	0.66	1.5	2.52	21.9	36.1	45.9	5790	429	11.2	460.5	420	62.2	3.02	95.67	11.94	155.0	497.1	220	3.56	0.65	70871	3.57	124.2
30	15	1.07	30	0.71	1.5	2.57	24.8	42.2	53.8	8360	557	12.5	602.1	604	80.5	3.35	123.9	15.57	171.9	540.0	245	3.95	0.64	126379	3.96	145.3
33	16	1.15	33	0.75	1.8	2.95	27.1	49.1	62.6	11770	713	13.7	762.8	788	98.5	3.55	151.5	20.54	182.2	564.5	270	4.21	0.63	199841	4.20	159.0
36	17	1.27	36	0.80	1.8	3.07	29.8	57.1	72.7	16270	904	15.0	973.7	1040	123	3.79	188.9	28.93	194.5	603.6	294	4.47	0.62	313605	4.47	167.9
40	18	1.35	40	0.86	2.1	3.45	33.1	66.3	84.5	23130	1160	16.5	1238	1320	146	3.95	225.6	37.43	202.7	621.5	326	4.71	0.61	492961	4.69	185.0
45	19	1.46	45	0.94	2.1	3.56	37.8	77.6	98.8	33740	1500	18.5	1624	1680	176	4.12	272.8	51.07	211.4	646.9	365	4.94	0.60	796207	4.94	201.3
50	20	1.60	50	1.02	2.1	3.70	42.6	90.7	116.0	48200	1930	20.4	2107	2140	214	4.31	332.2	71.17	221.2	675.7	404	5.18	0.59	1253270	5.18	214.0
55	21	1.72	55	1.11	2.4	4.12	46.7	106	134.0	67120	2440	22.3	2662	2670	254	4.45	395.1	94.74	228.3	699.1	442	5.40	0.59	1894871	5.40	228.0
60	22	1.90	60	1.20	2.4	4.30	51.4	122	156.0	92080	3070	24.3	3376	3390	308	4.66	480.0	133.0	239.1	736.1	481	5.65	0.58	2860829	5.66	236.5

نیمرخ INP

INP	bf	tf	d	tw=r1	r2	c	d-2c	A	G	I _x	S _x	r _x	I _y	S _y	r _y	a1	rT
	cm	cm	cm	cm	cm	cm	cm	cm ²	kg/m	cm ⁴	cm ³	cm	cm ⁴	cm ³	cm	cm	cm
8.0	4.2	0.59	8.0	0.39	0.23	1.05	5.9	7.57	5.94	77.8	19.5	3.20	6.29	3.00	0.91	6.2	1.12
10.0	5.0	0.68	10.0	0.45	0.27	1.25	7.5	10.6	8.34	171.0	34.2	4.01	12.2	4.88	1.07	7.8	1.33
12.0	5.8	0.77	12.0	0.51	0.31	1.40	9.2	14.2	11.1	328.0	54.7	4.81	21.5	7.41	1.23	9.4	1.54
14.0	6.6	0.86	14.0	0.57	0.34	1.55	10.9	18.2	14.3	573.0	81.9	5.61	35.2	10.7	1.40	10.8	1.74
16.0	7.4	0.95	16.0	0.63	0.38	1.75	12.5	22.8	17.9	935	117	6.40	54.7	14.8	1.55	12.4	1.95
18.0	8.2	1.04	18.0	0.69	0.41	1.90	14.2	27.9	21.9	1450	161	7.20	81.3	19.8	1.71	14.0	2.16
20.0	9.0	1.13	20.0	0.75	0.45	2.05	15.9	33.4	26.2	2140	214	8.00	117	26.0	1.87	15.6	2.36
22.0	9.8	1.22	22.0	0.81	0.49	2.20	17.6	39.5	31.1	3060	278	8.80	162	33.1	2.02	17.2	2.57
24.0	10.6	1.31	24.0	0.87	0.52	2.40	19.2	46.1	36.2	4250	354	9.59	221	41.7	2.20	18.8	2.78
26.0	11.3	1.41	26.0	0.94	0.56	2.60	20.8	53.3	41.9	5740	442	10.4	288	51.0	2.32	20.2	2.96
28.0	11.9	1.52	28.0	1.01	0.61	2.75	22.5	61.0	47.9	7590	542	11.1	364	61.2	2.45	21.8	3.11
30.0	12.5	1.62	30.0	1.08	0.65	2.95	24.1	69.0	54.2	9800	653	11.9	451	72.2	2.56	23.4	3.26
32.0	13.1	1.73	32.0	1.15	0.69	3.10	25.8	77.7	61.0	12510	782	12.7	555	84.7	2.67	24.8	3.41
34.0	13.7	1.83	34.0	1.22	0.73	3.30	27.4	86.7	68.0	15700	923	13.5	674	98.4	2.80	26.4	3.56
36.0	14.3	1.95	36.0	1.30	0.78	3.50	29.0	97	76.1	19610	1090	14.2	818	114	2.90	27.8	3.72
38.0	14.9	2.05	38.0	1.37	0.82	3.70	30.6	107	84.0	24010	1260	15.0	975	131	3.02	29.4	3.87
40.0	15.5	2.16	40.0	1.44	0.86	3.85	32.3	118	92.4	29210	1460	15.7	1160	149	3.13	30.8	4.02
42.5	16.3	2.30	42.5	1.53	0.92	4.10	34.3	132	104	36970	1740	16.7	1440	176	3.30	32.8	4.22
45.0	17.0	2.43	45.0	1.62	0.97	4.35	36.3	147	115	45850	2040	17.7	1730	203	3.43	34.8	4.40
47.5	17.8	2.56	47.5	1.71	1.03	4.55	38.4	163	128	56480	2380	18.6	2090	235	3.60	36.6	4.60
50.0	18.5	2.70	50.0	1.80	1.08	4.80	40.4	179	141	68740	2750	19.6	2480	268	3.72	38.4	4.78
55.0	20.0	3.00	55.0	1.90	1.19	5.25	44.5	212	166	99180	3610	21.6	3490	349	4.02	42.4	5.18
60.0	21.5	3.24	60.0	2.16	1.30	5.75	48.5	254	199	139000	4630	23.6	4670	434	4.30	46.0	5.54

نیمرخ IPB

IPB	bf	tf	d	tw	r	K	d-2K	G	A	I _x	S _x	r _x	Z _x	I _y	S _y	r _y	Z _y	J	r _{ts}	L _p	L _r	r _t	K _c	C _w	√ECw/GJ
units	cm	cm	cm	cm	cm	cm	cm	kg/m	cm ²	cm ⁴	cm ³	cm	cm ³	cm ⁴	cm ³	cm	cm ³	cm ⁴	cm	cm	cm	mm		cm ⁶	cm
10	10	1	10	0.6	1.2	2.2	5.6	20.4	26	450	89.9	4.16	99.6	167	33.5	2.53	50.7	7.24	2.89	129.8	922.5	27.8	0.76	3381.8	34.8
12	12	1.1	12	0.65	1.2	2.3	7.4	26.7	34	864	144	5.04	159.5	318	52.9	3.06	80.2	11.55	3.47	157.0	1006.6	33.4	0.76	9445.4	46.1
14	14	1.2	14	0.7	1.2	2.4	9.2	33.7	43	1510	216	5.93	238.6	550	78.5	3.58	119	17.45	4.04	183.7	1089.0	38.9	0.76	22528	57.9
16	16	1.3	16	0.8	1.5	2.8	10.4	42.6	54.3	2490	311	6.78	341.7	889	111	4.05	168.5	25.72	4.58	207.8	1171.3	44.4	0.76	48026	69.7
18	18	1.4	18	0.85	1.5	2.9	12.2	51.2	65.3	3830	426	7.66	467.4	1360	151	4.57	229.5	36.04	5.15	234.5	1256.3	49.9	0.76	93690	82.2
20	20	1.5	20	0.9	1.8	3.3	13.4	61.3	78.1	5700	570	8.54	620	2000	200	5.07	303.4	49.13	5.70	260.2	1334.5	55.5	0.76	171125	95.2
22	22	1.6	22	0.95	1.8	3.4	15.2	71.5	91	8090	736	9.43	802	2840	258	5.59	391.4	65.45	6.27	286.8	1426.0	61	0.76	295474	108.3
24	24	1.7	24	1	2.1	3.8	16.4	83.2	106	11260	938	10.3	1016	3920	327	6.08	494.8	85.47	6.83	312.0	1507.6	66.6	0.76	487344	121.8
26	26	1.75	26	1	2.4	4.15	17.7	93	118	14920	1150	11.2	1230	5130	395	6.58	597.1	100.40	7.35	337.6	1536.9	72.2	0.76	754190	139.8
28	28	1.8	28	1.05	2.4	4.2	19.6	103	131	19270	1380	12.1	1477	6590	471	7.09	712.3	118.28	7.91	363.8	1587.1	77.6	0.76	1130910	157.7
30	30	1.9	30	1.1	2.7	4.6	20.8	117	149	25170	1680	13	1790	8560	571	7.58	862.9	148.80	8.46	388.9	1671.7	83.2	0.76	1689765	171.8
32	30	2.05	32	1.15	2.7	4.75	22.5	127	161	30820	1930	13.8	2066	9240	616	7.57	931.7	186.45	8.47	388.4	1689.0	83.1	0.76	2072076	170.0
34	30	2.15	34	1.2	2.7	4.85	24.3	134	171	36660	2160	14.6	2319	9690	646	7.53	978.2	215.87	8.45	386.4	1666.9	82.9	0.76	2457439	172.0
36	30	2.25	36	1.25	2.7	4.95	26.1	142	181	43190	2400	15.5	2588	10140	676	7.49	1025	248.32	8.44	384.3	1649.3	82.7	0.76	2887523	173.9
40	30	2.4	40	1.35	2.7	5.1	29.8	155	198	57680	2880	17.1	3125	10820	721	7.4	1096	305.35	8.40	379.7	1587.1	82.3	0.76	3824221	180.5
45	30	2.6	45	1.4	2.7	5.3	34.4	171	218	79890	3550	19.1	3862	11720	781	7.33	1190	387.92	8.37	376.1	1525.2	81.9	0.75	5267437	187.9
50	30	2.8	50	1.45	2.7	5.5	39	187	239	107200	4290	21.2	4679	12620	842	7.27	1283	484.16	8.33	373.0	1476.5	81.6	0.72	7028835	194.3
55	30	2.9	55	1.5	2.7	5.6	43.8	199	254	136700	4970	23.2	5440	13080	872	7.17	1333	543.13	8.28	367.9	1399.4	81.1	0.70	8876121	206.1
60	30	3	60	1.55	2.7	5.7	48.6	212	270	171000	5700	25.2	6260	13530	902	7.08	1382	607.03	8.22	363.3	1336.6	80.7	0.68	10989743	217.0
65	30	3.1	65	1.6	2.7	5.8	53.4	225	286	210600	6480	27.1	7140	13980	932	6.99	1433	676.10	8.17	358.7	1285.0	80.2	0.66	13391477	226.9
70	30	3.2	70	1.7	2.7	5.9	58.2	241	306	256900	7340	29	8132	14440	963	6.87	1486	759.52	8.11	352.5	1242.7	79.6	0.65	16108686	234.8
80	30	3.3	80	1.75	3	6.3	67.4	262	334	359100	8980	32.8	9950	14900	994	6.68	1541	849.87	7.98	342.8	1149.7	78.7	0.62	21913765	258.9
90	30	3.5	90	1.85	3	6.5	77	291	371	494100	10980	36.5	12269	15820	1050	6.53	1646	1032.67	7.89	335.1	1104.0	77.9	0.60	29592299	273.0
100	30	3.6	100	1.9	3	6.6	86.8	314	400	644700	12890	40.1	14502	16280	1090	6.38	1704	1145.29	7.80	327.4	1053.7	77	0.57	37822347	293.0

نیمرخ UNP

UNP	bf	tf=r1	d	tw	r2	c	d-2c	A	G	I _x	S _x	r _x	I _y	S _y	r _y	e _y	xM	a1
	cm	cm	cm	cm	cm	cm	cm	cm ²	kg/m	cm ⁴	cm ³	cm	cm ⁴	cm ³	cm	cm	cm	mm
60	3.0	0.60	6.0	0.60	0.30	1.25	3.5	6.46	5.07	31.6	10.5	2.21	4.51	2.16	0.84	0.91	1.50	--
65	4.2	0.75	6.5	0.55	0.40	1.60	3.3	9.03	7.09	57.5	17.7	2.52	14.1	5.07	1.25	1.42	2.60	16.0
80	4.5	0.80	8.0	0.60	0.40	1.70	4.7	11.0	8.64	106.0	26.5	3.10	19.4	6.36	1.33	1.45	2.67	28.0
100	5.0	0.85	10	0.60	0.45	1.80	6.4	13.5	10.6	206.0	41.2	3.91	29.3	8.49	1.47	1.55	2.93	42.0
120	5.5	0.90	12	0.70	0.45	1.90	8.2	17.0	13.4	364.0	60.7	4.62	43.2	11.1	1.59	1.60	3.03	56.0
140	6.0	1.00	14	0.70	0.50	2.10	9.7	20.4	16.0	605.0	86.4	5.45	62.7	14.8	1.75	1.75	3.37	70.0
160	6.5	1.05	16	0.75	0.55	2.25	11.6	24.0	18.8	925.0	116	6.21	85.3	18.3	1.89	1.84	3.56	82.0
180	7.0	1.10	18	0.80	0.55	2.35	13.3	28.0	22.0	1350	150	6.95	114	22.4	2.02	1.92	3.75	96.0
200	7.5	1.15	20	0.85	0.60	2.45	15.1	32.2	25.3	1910	191	7.70	148	27.0	2.14	2.01	3.94	108
220	8.0	1.25	22	0.90	0.65	2.65	16.6	37.4	29.4	2690	245	8.48	197	33.6	2.30	2.14	4.20	122
240	8.5	1.30	24	0.95	0.65	2.80	18.5	42.3	33.2	3600	300	9.22	248	39.6	2.42	2.23	4.39	134
260	9.0	1.40	26	1.00	0.70	3.00	20.1	48.3	37.9	4820	371	9.99	317	47.7	2.56	2.36	4.66	146
280	9.5	1.50	28	1.00	0.75	3.20	21.6	53.3	41.8	6280	448	10.9	399	57.2	2.74	2.53	5.02	160
300	10.0	1.60	30	1.00	0.80	3.40	23.2	58.8	46.2	8030	535	11.7	495	67.8	2.90	2.70	5.41	174
320	10.0	1.75	32	1.40	0.88	3.70	24.7	75.8	59.5	10870	679	12.1	597	80.6	2.81	2.60	4.82	182
350	10.0	1.60	35	1.40	0.80	3.40	28.3	77.3	60.6	12840	734	12.9	570	75.0	2.72	2.40	4.45	204
380	10.2	1.60	38	1.35	0.80	3.35	31.3	80.4	63.1	15760	829	14.0	615	78.7	2.77	2.38	4.58	227
400	11.0	1.80	40	1.40	0.90	3.80	32.5	91.5	71.8	20350	1020	14.9	846	102.0	3.04	2.65	5.11	240

نمونه‌ها

b x t	r1	r2	F	G	e	w	v1	lx=ly	Sx=Sy	rx=ry	I _x	r _x	I _y	S _y	r _y
cm	cm	cm	cm ²	kg/m	cm	cm	cm	cm ⁴	cm ³	cm	cm ⁴	cm	cm	cm ³	cm
6x0.6	0.80	0.40	6.91	5.42	1.69	4.24	2.39	22.8	5.29	1.82	36.1	2.29	9.43	3.95	1.17
8x0.8	1.00	0.50	12.30	9.66	2.26	5.66	3.20	72.3	12.6	2.42	115	3.06	29.6	9.25	1.55
10x1.0	1.20	0.60	19.20	15.10	2.82	7.07	3.99	177	24.7	3.04	280	3.82	73.3	18.4	1.95
12x1.2	1.30	0.65	27.50	21.60	3.40	8.49	4.80	368	42.7	3.65	584	4.60	152	31.6	2.35
14x1.5	1.50	0.75	40.00	31.40	4.00	9.90	5.66	723	72.3	4.25	1150	5.36	298	52.7	2.73
16x1.5	1.70	0.85	46.10	36.20	4.49	11.30	6.35	1100	95.6	4.88	1750	6.15	453	71.3	3.14
18x1.8	1.80	0.90	61.90	48.60	5.10	12.70	7.22	1870	145	5.49	2970	6.93	757	105	3.49
20x2.0	1.80	0.90	76.40	59.90	5.68	14.10	8.04	2850	199	6.11	4540	7.72	1160	144	3.89

IPe زنبوری (CPE)

Cast IPE	h	H	tf	tw	Aa	G (per 1.5h)	I _{xa}	S _{xa}	Ab	I _{xb}	S _{xb}
	cm	cm	cm	cm	cm ²	kg/m	cm ⁴	cm ³	cm ²	cm ⁴	cm ³
12	8	12	0.52	0.38	9.16	0.72	206	34.3	6.12	189	31.6
15	10	15	0.57	0.41	12.4	1.21	437	58.2	8.25	403	53.7
18	12	18	0.63	0.44	15.8	1.86	809	89.9	10.6	746	82.8
21	14	21	0.69	0.47	19.7	2.70	1370	131	13.1	1270	121
24	16	24	0.74	0.50	24.1	3.78	2200	184	16.1	2030	169
27	18	27	0.80	0.53	28.7	5.06	3330	247	19.1	3070	228
30	20	30	0.85	0.56	34.1	6.70	4910	327	22.9	4540	302
33	22	33	0.92	0.59	39.9	8.63	6990	423	26.9	6460	392
36	24	36	0.98	0.62	46.5	11.00	9790	544	31.7	9070	504
41	27	41	1.02	0.66	54.8	14.60	14550	719	37.0	13470	665
45	30	45	1.07	0.71	64.5	19.00	21010	934	43.2	19410	863
50	33	50	1.15	0.75	75.0	24.30	29580	1200	50.2	27330	1100
54	36	54	1.27	0.80	87.1	30.80	40890	1510	58.3	37780	1400
60	40	60	1.35	0.86	102	39.70	58290	1940	67.3	53700	1790
68	45	68	1.46	0.94	120	52.20	85430	2530	77.7	78290	2320
75	50	75	1.60	1.02	142	68.20	122400	3260	90.5	111800	2980
83	55	83	1.72	1.11	165	86.60	171100	4150	103	155700	3770
90	60	90	1.90	1.20	192	110.00	235300	5230	120	213700	4750