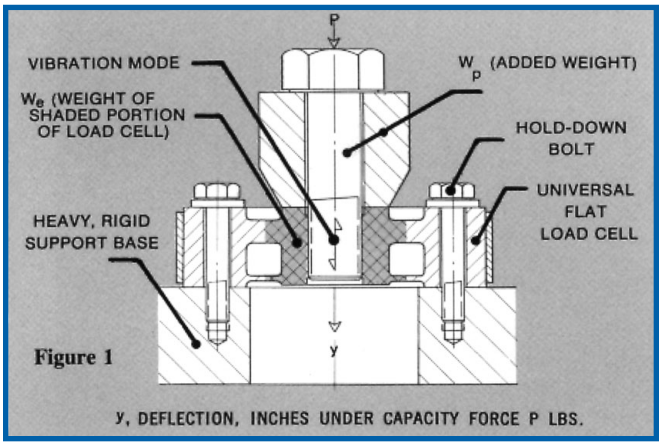
Flat Load Cell® Technical Information

Mechanical Properties of Flat Load Cells®

Deflection, Spring Rate, and Natural Frequencies for Universal and Compression Flat Load Cells are given in tabular form.

These mechanical properties of the load cells are based on the installation of Figure 1, in which the outer rim of the cell is clamped to a heavy, rigid base which deflects negligibly under load, and does not vibrate when excited by the load cell forces. The force P is applied axially at the center of the load cell.



Deflection y represents the axial deflection of the cell under capacity load P.

The Spring Rate K = P/y is the Stiffness of the load cell in the axial direction, and is the ratio between the force P and deflection y.

The effective weight W_e is that portion of the load cell weight which is shown in Figure 1. It consists of the weight of the center hub and inboard parts of the reduced section and diaphragm which vibrate at or near full amplitude when the load cell is dynamically excited. The outer rim of the load cell and adjacent parts (not shaded) are assumed to be motionless, since they are held by the heavy base. The effective vibrating weight of the load cell is different than shown, when its outer rim is flexibly supported and participates in the vibration.

The tabulated values of axial natural frequency f_c are those obtained when no weights W_b are attached to the hub of the load cell, which vibrates freely. By definition, this is the natural frequency of a single-degree-of-freedom system consisting of spring K and weight W_e. This is the highest possible axial natural frequency of a load cell installation, since any loading member will add mass to the center, hence, reduce the frequency.

In order to give an example of natural frequency reduction as weight is added to the hub, values of natural frequency f_p are listed for each load cell for the case when this additional weight W_p is equal to 0.001 P, as illustrated in Figure 1. Thus, the 50,000 pound capacity Universal Flat Load Cell with 2-mv/v sensitivity, has a natural frequency of 11,400 cps without any added weights, but this is reduced to a natural frequency f_p of 2,000 cps when a weight W_p of 50 pounds is added.

To determine the axial natural frequency f_x of any flat load cell system with any other added weight W_p (pounds) while rigidly supported as in Figure 1, the following equation may be used:

$$f_x = 3.13 \sqrt{\frac{K}{We + Wp}} \quad \text{cps}$$

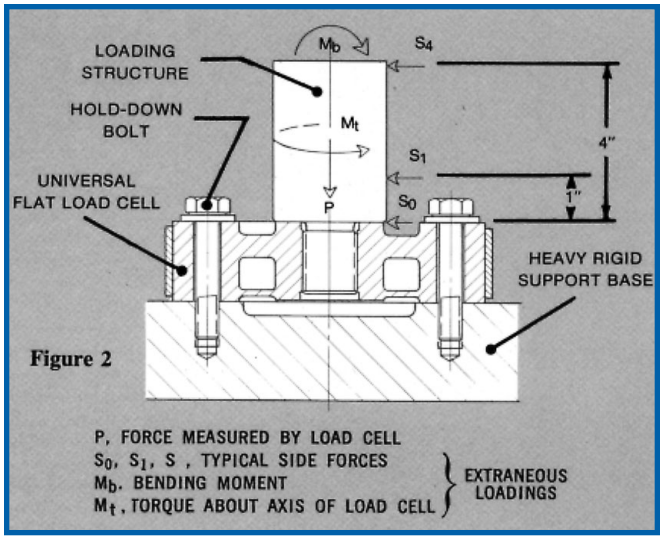
When the external weight W_p is relatively large, its motion may have to be restricted to the axial vibration mode by means of suitable guides. If not, natural frequencies of lateral modes could possibly be lower than those tabulated.

All tabulated values are obtained by analysis, and expected accuracy is within 15 to 20 percent.

Extraneous Loading Capacities of Universal Flat Load Cells®

The Universal Flat Load Cells® are designed to withstand extraneous loadings, in addition to the measured axial force P. Some typical extraneous loadings are tabulated, and are identified in Figure 2. These are lateral loads S_0 (along the top of the cell), S_1 (acting 1-inch above the top of the cell) and S_4 (acting 4-inches above the top of the load cell). Also shown are bending moment Mb and torque Mt, applied to the center hub of the cell. It is assumed that any one of these would be applied individually, and not in combination with each other.

The tabulated values of extraneous loadings, applied individually will not cause permanent damage to the load cells. Allowable extraneous loadings are half the values tabulated if applied in conjunction with other extraneous loads or measured load P.



Mechanical Properties of Universal Flat Load Cells®

Force Capacity P Lbs.	Model	Mechanical Properties (Fig.1 - Page 69)						Extraneous Loading Capacity (Fig. 2 - Page 69)				
		Full Load Deflection y Inches	Spring Rate K lbs./Inch	Load Cell Without External Weights (W_e Only)		Load Cell With External Weights (W_p =0.001 P)		Side Loads Lbs.			Bending Moment M_b Inch-Lbs.	Torque M_t Inch-Lbs.
				W_e Lbs.	Nat. Freq. f_c, Cps.	W_p Lbs.	Nat. Freq. f_p, Cps.	S_o	S_1	S_4		
250	FL025U(C)-2SG,-2SP FL025U(C)-2DG,-2DP	0.00027	920,000	0.023	19,800	0.25	5,700	500	160	50	240	300
500	FL05U(C)-2SG,-2SP FL05U(C)-2DG,2DP	0.00054	920,000	0.023	19,800	0.50	4,150	500	160	50	240	300
1,000	FL1U(C)-2SG,-2SP FL1U(C)-2DG,-2DP	0.00076	1,310,000	0.022	24,200	1.0	3,550	840	240	80	350	440
	FL1U(C)-3SG,-3SP FL1U(C)-3DG,-3DP	0.00078	1,130,000	0.022	23,600	1.0	3,300	660	200	60	270	340
2,500	FL2.5U(C)-2SG,-2SP FL2.5U(C)-2DG,-2DP	0.00075	3,330,000	0.041	28,400	2.5	3,600	2,500	750	230	1,000	1,710
	FL2.5U(C)-3SG,-3SP FL2.5U(C)-3DG,-3DP	0.00091	2,750,000	0.039	26,300	2.5	3,260	2,300	750	230	1,000	1,100
5,000	FL5U(C)-2SG,-2SP FL5U(C)-2DG,-2DP	0.00085	5,880,000	0.091	25,000	5.0	3,300	4,400	1,300	400	1,700	2,700
	FL5U(C)-3SG,-3SP FL5U(C)-3DG,-3DP	0.00100	5,000,000	0.091	23,200	5.0	3,100	3,200	1,000	350	1,400	1,900
7,500	FL7.5U(C)-2SG,-2SP FL7.5U(C)-2DG,-2DP	0.00100	7,500,000	0.096	27,600	7.5	3,100	6,000	1,530	480	2,070	4,200
	FL7.5U(C)-3SG,-3SP FL7.5U(C)-3DG,-3DP	0.00128	5,880,000	0.091	25,000	7.5	2,750	4,400	1,300	400	1,700	2,700
10,000	FL10U(C)-2SG,-2SP FL10U(C)-2DG,-2DP	0.00088	11,300,000	0.224	22,200	10.0	3,300	10,000	3,070	1,000	4,350	8,000
	FL10U(C)-3SG,-3SP FL10U(C)-3DG,-3DP	0.00104	9,600,000	0.224	20,500	10.0	3,000	8,000	2,500	820	3,600	4,400
25,000	FL25U(C)-2SG,-2SP FL25U(C)-2DG,-2DP	0.00148	16,900,000	0.784	14,500	25.0	2,530	25,000	10,000	3,500	16,000	33,600
	FL25U(C)-3SG,-3SP FL25U(C)-3DG,-3DP	0.00179	14,000,000	0.784	13,200	25.0	2,310	20,000	8,000	2,800	12,800	22,800
35,000	FL35U(C)-2SG,-2SP FL35U(C)-2DG,-2DP	0.00164	21,300,000	1.280	12,700	35.0	2,400	35,000	17,000	6,100	28,500	60,000
	FL35U(C)-3SG,-3SP FL35U(C)-3DG,-3DP	0.00200	17,500,000	1.280	11,700	35.0	2,200	33,000	13,700	5,000	23,000	45,000
50,000	FL50U(C2)-2SG,-2SP FL50U(C2)-2DG,-2DP	0.00234	21,400,000	1.620	11,400	50.0	2,000	50,000	21,000	7,700	37,000	84,000
	FL50U(C2)-3SG,-3SP FL50U(C2)-3DG,-3DP	0.00266	18,800,000	1.620	10,700	50.0	1,890	41,500	17,800	6,570	31,200	52,000
75,000	FL75U(C1)-2SG,-2SP FL75U(C1)-2DG,-2DP	0.00252	29,800,000	3.830	8,730	75.0	1,920	75,000	40,000	16,000	78,000	170,000
	FL75U(C1)-3SG,-3SP FL75U(C1)-3DG,-3DP	0.00328	23,000,000	3.830	7,670	75.0	1,690	59,000	29,000	11,500	57,000	104,000
100,000	FL100U(C)-2SG,-2SP FL100U(C)-2DG,-2DP	0.00306	32,600,000	6.350	7,100	100.0	1,730	100,000	52,000	22,000	110,000	250,000
	FL100U(C)-3SG,-3SP FL100U(C)-3DG,-3DP	0.00400	25,000,000	6.350	6,210	100.0	1,520	72,500	38,000	15,700	80,000	160,000
150,000	FL150U(C)-2SG,-2SP FL150U(C)-2DG,-2DP	0.00312	48,000,000	13.0	6,000	150.0	1,700	150,000	100,000	43,000	233,000	500,000
	FL150U(C)-3SG,-3SP FL150U(C)-3DG,-3DP	0.00410	37,000,000	13.0	5,300	150.0	1,500	125,000	71,000	31,000	166,000	300,000
200,000	FL200U(C)-2SG,-2SP FL200U(C)-2DG,-2DP	0.00423	47,300,000	17.0	5,200	200.0	1,460	200,000	122,000	55,000	300,000	700,000
300,000	FL300U(C)-2SG,-2SP FL300U(C)-2DG,-2DP	0.00506	59,300,000	22.7	5,060	300.0	1,340	300,000	208,000	100,000	550,000	1,250,000
400,000	FL400U(C)-2SG,-2SP FL400U(C)-2DG,-2DP	0.00586	68,000,000	32.2	4,600	400.0	1,250	400,000	264,000	130,000	760,000	1,800,000

Tabulated Allowables are for individually applied extraneous loads.
Applied in combination, or in conjunction with load P, Allowable extraneous loads are half of the tabulated values.

Mechanical Properties of Compression Flat Load Cells®

Force Capacity P Lbs.	Model	Full Load Deflection y Inches	Spring Rate K Lbs./Inch	Load Cell Without External Weights (W_e Only)		Load Cell With External Weights (W_p =0.001 P)	
				W_e Lbs.	Nat. Freq. F_c Cps.	W_p Lbs.	Nat. Freq. F_p Cps.
250	FL025C(C)-2SG,-2SP FL025C(C)-2DG,-2DP	0.00027	920,000	0.028	18,000	0.25	5,700
500	FL05C(C)-2SG,-2SP FL05C(C)-2DG,-2DP	0.00054	920,000	0.028	18,000	0.5	4,150
1,000	FL1C(C)-2SG,-2SP FL1C(C)-2DG,-2DP	0.00082	1,220,000	0.023	22,800	1.0	3,420
	FL1C(C)-3SG,-3SP FL1C(C)-3DG,-3DP	0.00095	1,050,000	0.023	21,200	1.0	3,170
2,500	FL2.5C(C)-2SG,-2SP FL2.5C(C)-2DG,-2DP	0.00114	2,200,000	0.040	23,300	2.5	2,930
	FL2.5C(C)-3SG,-3SP FL2.5C(C)-3DG,-3DP	0.00138	1,810,000	0.040	21,000	2.5	2,620
5,000	FL5C(C)-2SG,-2SP FL5C(C)-2DG,-2DP	0.00076	6,600,000	0.135	22,000	5.0	3,560
	FL5C(C)-3SG,-3SP FL5C(C)-3DG,-3DP	0.00089	5,600,000	0.135	20,000	5.0	3,270
10,000	FL10C(C)-2SG,-2SP FL10C(C)-2DG,-2DP	0.00118	8,500,000	0.34	15,700	10.0	2,850
	FL10C(C)-3SG,-3SP FL10C(C)-3DG,-3DP	0.00140	7,100,000	0.34	14,400	10.0	2,600
25,000	FL25C(C)-2SG,-2SP FL25C(C)-2DG,-2DP	0.00213	11,700,000	0.69	13,000	25.0	2,120
	FL25C(C)-3SG,-3SP FL25C(C)-3DG,-3DP	0.00233	10,700,000	0.69	12,700	25.0	2,030
50,000	FL50C(C)-2SG,-2SP FL50C(C)-2DG,-2DP	0.00246	20,400,000	1.58	11,300	50.0	1,980
	FL50C(C)-3SG,-3SP FL50C(C)-3DG,-3DP	0.00259	19,300,000	1.58	11,000	50.0	1,930
100,000	FL100C(C)-2SG,-2SP FL100C(C)-2DG,-2DP	0.00349	28,600,000	4.50	7,900	100.0	1,640
	FL100C(C)-3SG,-3SP FL100C(C)-3DG,-3DP	0.00370	27,200,000	4.50	7,700	100.0	1,600
150,000	FL150C(C)-2SG,-2SP FL150C(C)-2DG,-2DP	0.00434	34,600,000	6.56	7,200	150.0	1,480
	FL150C(C)-3SG,-3SP FL150C(C)-3DG,-3DP	0.00456	33,000,000	6.56	7,000	150.0	1,440
200,000	FL200C(C)-2SG,-2SP FL200C(C)-2DG,-2DP	0.00560	35,800,000	10.0	5,900	200.0	1,300
	FL200C(C)-3SG,-3SP FL200C(C)-3DG,-3DP	0.00590	34,000,000	10.0	5,800	200.0	1,260
300,000	FL300C(C)-2SG,-2SP FL300C(C)-2DG,-2DP	0.00700	43,000,000	17.7	4,900	300.0	1,160
500,000	FL500C(C)-2SG,-2SP FL500C(C)-2DG,-2DP	0.00770	65,000,000	33.0	4,400	500.0	1,100

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