Key Spring design calculations

Measurement of an existing chanters show that the force on the key applied by the finger can be anywhere between 35g and 80g to start the key opening and increases to anywhere between 60g and 300g as the key approaches fully open.

I feel that a reasonable target for the school chanter would be a starting force of around 60g and a fully open force of around 100g. The ideal is to have as little change of force as possible over the key movement.

The calculations below show the forces for a commercial coil compression spring. These calculations take no account of minor geometry changes due to manufacturing tolerance or friction.

Key	pivot to touch	pivot to spring	spring length max	spring length min	spring load at start (N)	spring load at finish (N)	start force on touch piece (g)	finish force on touch piece (g)
a	38	4	5.5	4.8	5.868	7.009	62.9	75.2
c#	14	3	5.2	4.2	2.783	5.313	60.8	116.0
F#	28	3.5	4.5	3.82	4.554	6.2744	58.0	79.9
E	40	4	5.5	4.6	5.868	7.335	59.8	74.7
D	55	5	5	4.6	6.683	7.335	61.9	67.9
			F# & C# keys use the D20910 spring					
No	D20920	D20910						
Spring rate (N)	1.63	2.53						
spring free length	9.1	6.3						

Output of the design optimisation spreadsheet

Comparative force measurements from taken traditional chanters

(first column is the starting to move force and the second is the fully open force)

	Ross G Nick Leeming's		Nelson F Nick Leeming's		Nelson G		Nelson F		Nelson F *		Burleigh F		Hedworth F		Nelson F (Kathryn's)	
Top b	60	75	30	60	50	85	30	60	20	70	70	85	100	170	30	55
Top a	30	54	30	60	40	85	35	70	20	85	50	150	75	200	40	190
Top d#	95	200	40	120	85	300	60	160	30	175	100	230	100	425	40	140
Top c#	30	180	36	55	60	200	36	60	60	140	50	420	100	145	40	160
Bottom F#	60	200	20	110	60	185	40	140	40	80	60	160	75	290	50	75
Bottom E	30	65	20	40	40	100	20	75	15	40	40	90	60	140	20	60
Bottom D	60	100	25	70	60	95	25	85	10	30	40	90	90	170	30	70

* *This chanter is one of the first I produced and has sheet brass keys*.

From this chart it is clear that there is considerable variation in the force needed to operate the keys on traditional leaf spring chanters.