PROBLEM 13-1

Statement: A linear spring is to give 200 N at its maximum deflection of 150 mm and 40 N at its minimum deflection of 50 mm. What is its spring rate?

Solution: Also see the *TKSolver* file P13-01.

Rule Sheet:

$k = (Fmax - Fmin) / (ymax - ymin)$

Variable Sheet:

St	Input	Name	Output	Unit	Comment
	200.	Fmax		N	Force at maximum deflection
	40.	Fmin		N	Force at minimum deflection
	150.	ymax		mm	maximum deflection
	50.	ymin		mm	minimum deflection
		k	1 600.	N/m	Spring rate

PROBLEM 13-3

Statement: Find the torsional yield and ultimate shear strength of an 0.105-in-dia, unset A230 wire to be used in a helical compression spring.

Solution: Also see the *TKSolver* file P13-03.

St	Input	Name	Output	Unit	Comment
		Sut	221 862.	psi	ult tensile strength eq 13.3&Tab 13–4
		Sus	148 648.	psi	ultim shear strength equation 13.4
		Ssy	110 931.	psi	shear yield based on Table 13–6

PROBLEM 13-4

Statement: What is the torsional fatigue strength of the wire in Problem 13-3 at N = 5E6 cycles?

Solution: Also see the *TKSolver* file P13-03.

Rule Sheet:

See the rule sheet for Problem 13-3. It includes the solution to this problem.

Variable Sheet:

St	Input	Name	Output	Unit	Comment
		Sse	45 000.	psi	endurance limit – equation 13.12
	5.0E6	N			Number of cycles for fatigue strength
	.39	frct			fatigue strength % – table 13–7
		Sfwprime	86 526.	psi	Torsional fatigue strength

PROBLEM 13-10
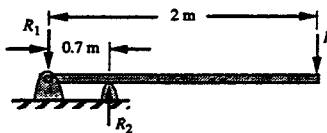
Statement: An overhung diving board is shown in Figure P13-1a. A 100-kg person is standing on the free end. Assume cross-sectional dimensions of 305 mm x 32 mm and a material E = 10.3 GPa. What is the spring rate and fundamental natural frequency of the diver-board combination?

Solution: Also see the *TKSolver* file P13-10.

FIGURE 13-10

Free body diagram for Problem 13-10

St	Input	Name	Output	Unit	Comment
	100.0	m		kg	person's mass
	981.0	F		N	End load
	2.00	l		m	beam length
	0.70	a		m	distance to support
	32.0	depth		mm	beam depth
	305.0	width		mm	beam width
	10.30	E		GPa	Modulus of elasticity
		I	8.329E-7	m^4	cross–section moment of inertia
		k	7 614.0	N/m	spring rate of diving board
		wn	8.73	rad/sec	natural frequency
		fn	1.39	Hz	natural frequency

Statement: Design a helical compression spring to handle a dynamic load that varies from 175 lb to 225 lb over a 0.85-in working deflection. Use squared and ground, unpeened music wire and a 10% clash allowance. The forcing frequency is 500 rpm. Infinite life is desired. Minimize the package size. Find safety factors against fatigue, yielding, and surging.

Assumptions: Use unpeened music wire, squared and ground ends, and setting. Allow 10% for clash.

Solution: Also see the *TKSolver* file P13-19.

St	Input	Name	Output	Unit	Comment
	225.00	Fmax		lb	maximum applied force
	175.00	Fmin		lb	mimimum applied force
	0.850	y		in	deflection of spring
L		k	58.82	lb/in	spring rate
L	11.0	C			trial spring index
..	0.250	dia			trial wire diameter
		d	0.250	in	available wire diameter (from List Function)
		D	2.75	in	mean coil diameter
L		Dout	3.00	in	outside coil diameter
L		Din	2.50	in	inside coil diameter
L		Lf	5.54	in	free length
L		Linstal	2.56	in	installed length
L		Lcomp	1.71	in	compressed length
L		Lshut	1.63	in	shut height
	10.	clash		%	% of deflection for clash allowance
		yinit	2.98	in	inital deflection at assembly
		ymax	3.83	in	max working deflection
		yclash	0.085	in	coil clash allowance
		yshut	3.91	in	deflection to shut height
		N	4.59		no of active coils – exact
		Na	4.50		no of active coils – to nearest 1/4 coil
		Ntot	6.50		no of total coils

Statement: Design a helical compression spring to handle a dynamic load that varies from 30 lb to 50 lb over a 1.25-in working deflection. Use squared, peened chrome-vanadium wire and a 15% clash allowance. The forcing frequency is 250 rpm. Infinite life is desired. Minimize the package size. Find safety factors against fatigue, yielding, and surging.

Assumptions: Use peened chrome vanadium wire, squared ends, and setting. Allow 15% for clash.

Solution: Also see the *TKSolver* file P13-20.

St	Input	Name	Output	Unit	Comment
	50.00	Fmax		lb	maximum applied force
	30.00	Fmin		lb	minimum applied force
	1.250	y		in	deflection of spring
L		k	16.00	lb/in	spring rate
					Spring dimensions
L	10.0	C			trial spring index
	0.112	dia			trial wire diameter
		d	0.112	in	available wire diameter (from List Function)
		D	1.12	in	mean coil diameter
L		Dout	1.23	in	outside coil diameter
L		Din	1.01	in	inside coil diameter
L		Lf	4.66	in	free length
L		Linstal	2.78	in	installed length
L		Lcomp	1.53	in	compressed length
L		Lshut	1.34	in	shut height
	15.	clash		%	% of deflection for clash allowance
		yinit	1.88	in	inital deflection at assembly
		ymax	3.13	in	max working deflection
		yclash	0.188	in	coil clash allowance
		yshut	3.31	in	deflection to shut height
		N	10.06		no of active coils – exact
		Na	10.00		no of active coils – to nearest 1/4 coil
		Ntot	12.00		no of total coils