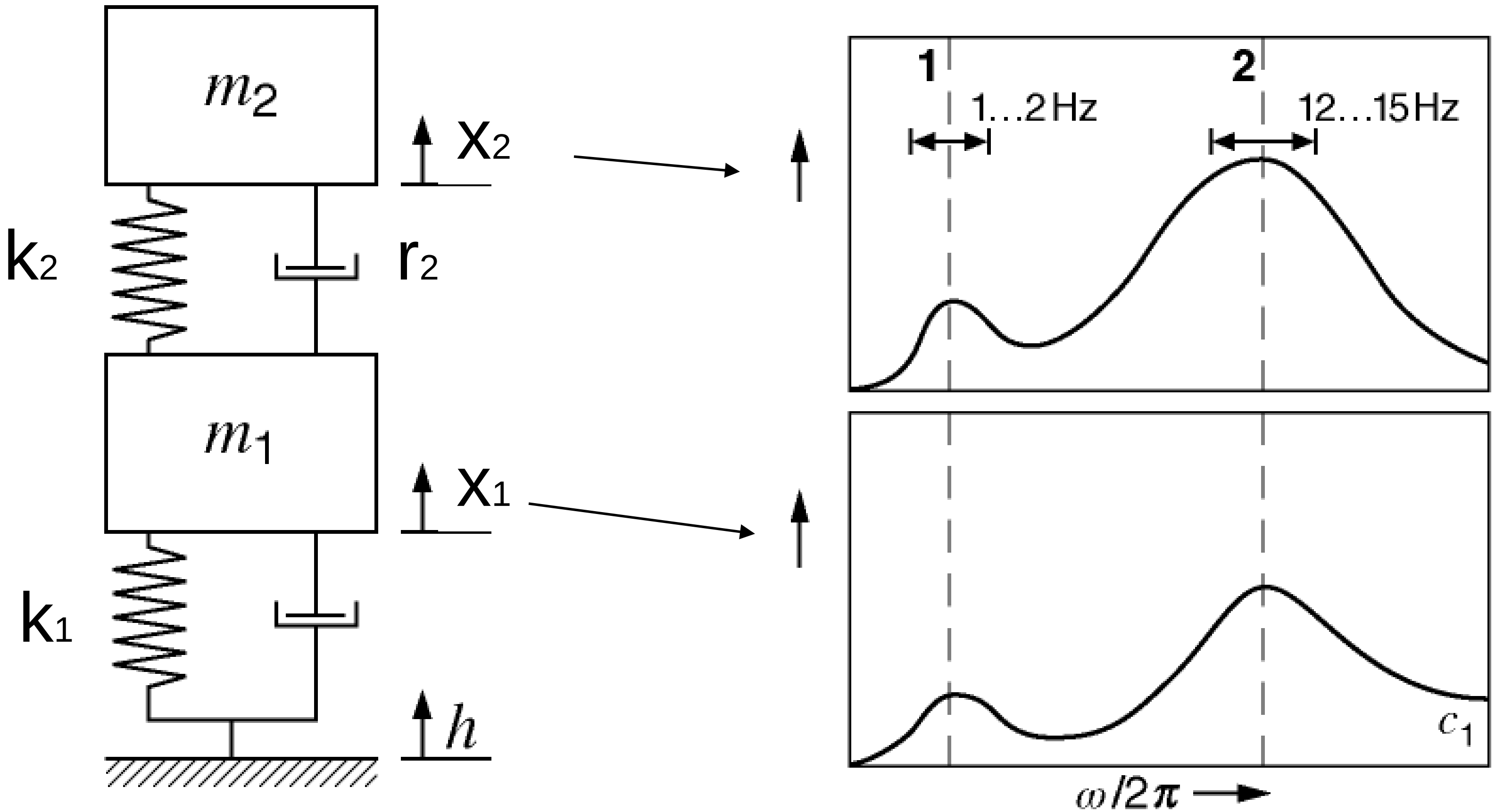
Road vehicles
passive suspension system

M. Gobbi 3/2016

Suspensions



Suspensions

Data of the reference road vehicle taken into consideration

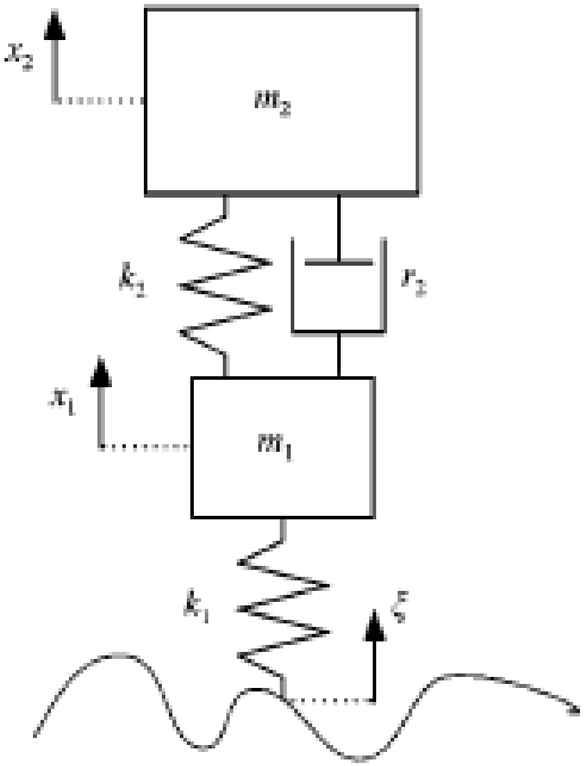
Parameter	Reference value	Lower and upper bound†
$m_{\ r}$ (kg)	229	114–458
$m_{\ r}$ (kg)	31	15–62
k_{1r} (N/m)	120 000	60 000–240 000
k_{2r} (N/m)	20 000	10 000–40 000
r_{2r} (N s/m)	1200	600–2400

† Lower and upper bounds refer to parameter sensitivity analysis.

TABLE 2

Data of the road roughness taken into consideration

Parameter	Reference value	
A_b	(m)	1·4e–5
$a = s_c/v$	(rad/m)	0·4
A_v	(m²)	3·5e–5



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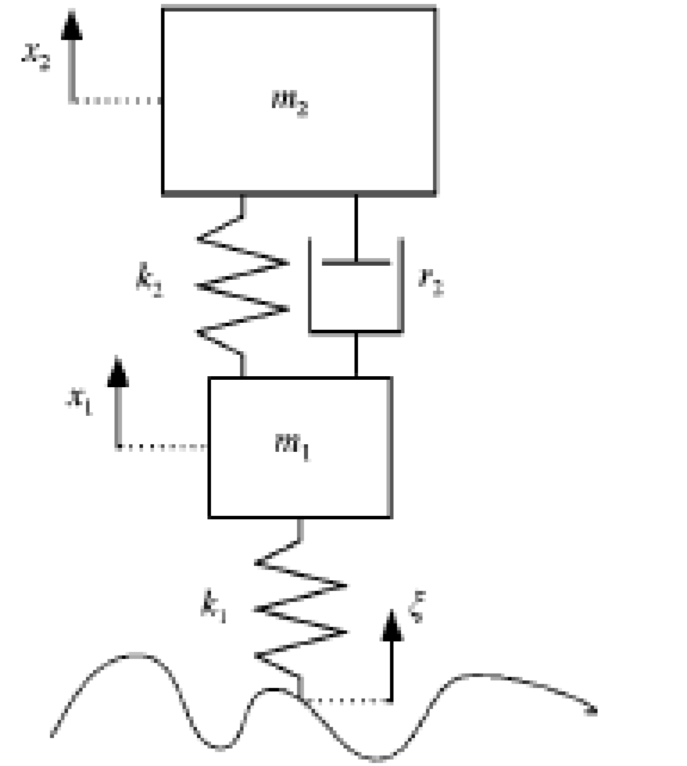


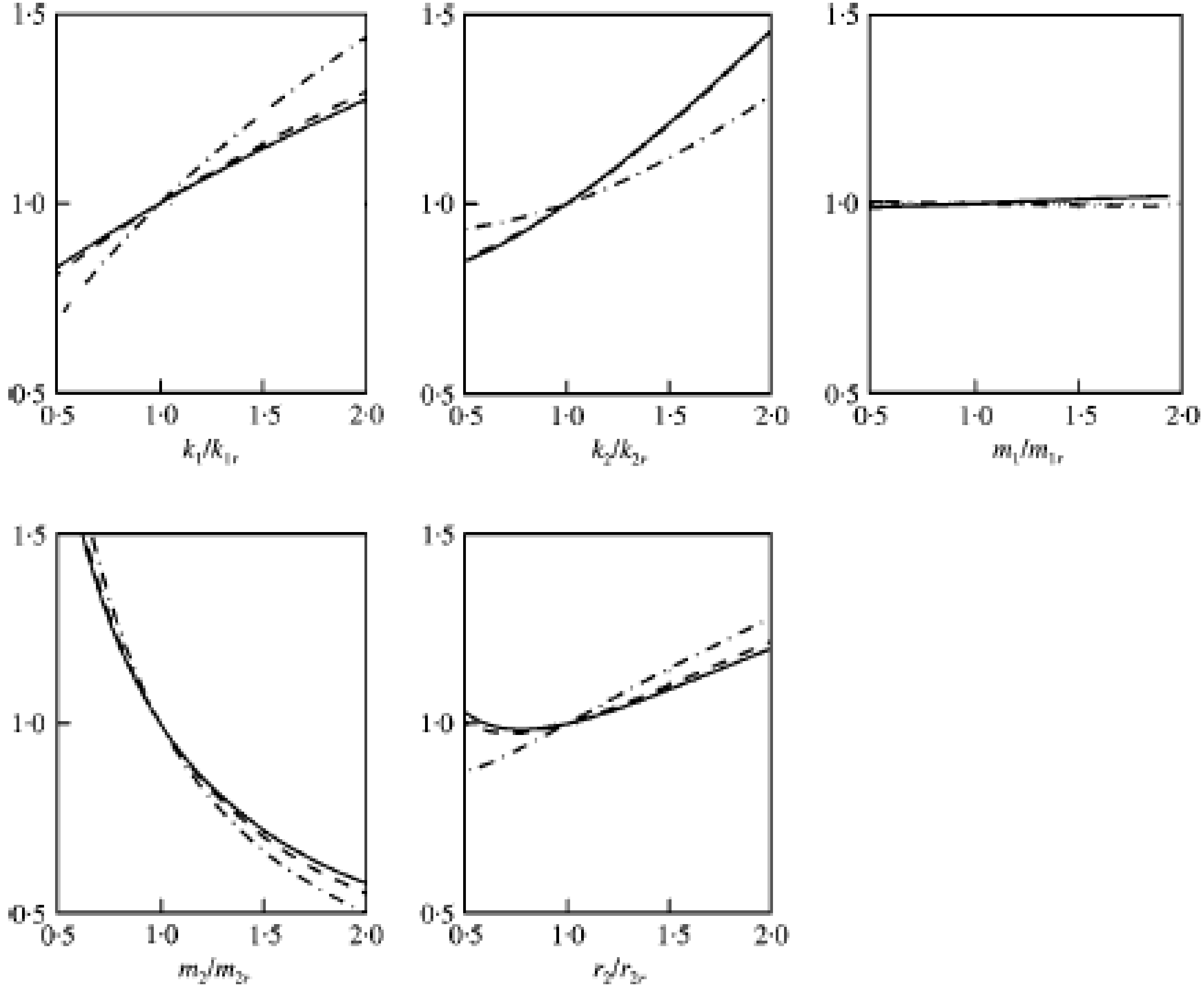
$$\sigma_{\ddot{x}_2} = A \cdot \sqrt{\frac{(m_1 + m_2)}{{m_2}^2 r_2} {k_2}^2 + \frac{k_1 r_2}{{m_2}^2}}$$

$$\sigma_{Fz} = A \cdot \sqrt{\frac{(m_1 + m_2)^3}{{m_2}^2 r_2} {k_2}^2 - 2\frac{m_1 k_1 (m_1 + m_2)}{m_2 r_2} k_2 + \frac{k_1 r_2 (m_1 + m_2)^2}{{m_2}^2} + \frac{{k_1}^2 m_1}{r_2}}$$

$$\sigma_{x_2 - x_1} = A \cdot \sqrt{\frac{m_1 + m_2}{r_2}}$$

$$A = \sqrt{1/2\, A_b v}$$

Suspensions



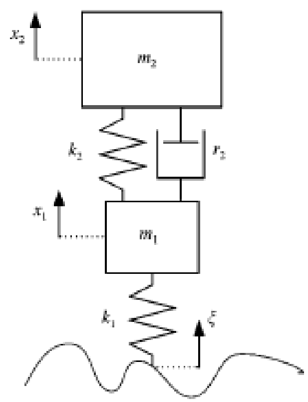
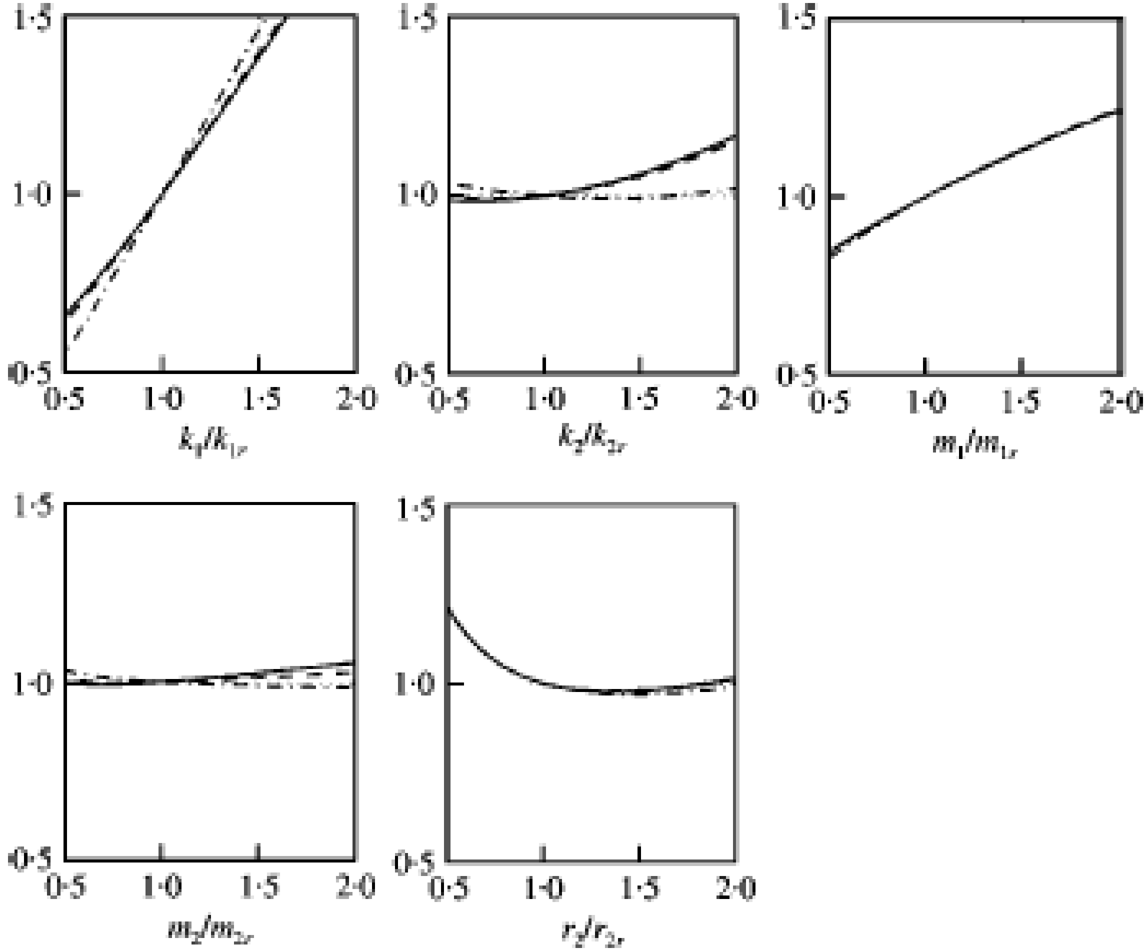


Figure 3. $\sigma_{\ddot{x}_2}/\sigma_{\ddot{x}_{2r}}$: non-dimensional standard deviation of the vertical body acceleration as function of mo
parameters. Data of the reference vehicle in Table 1, running condition data in Table 2. Each diagram has be
obtained by varying one single parameter, the other ones being constant and equal to those of the reference vehic
– – – –, 2S-PSD: v = 10 m/s; · – · – · –, 2S-PSD: v = 50 m/s; ——, 1S-PSD: any speed.



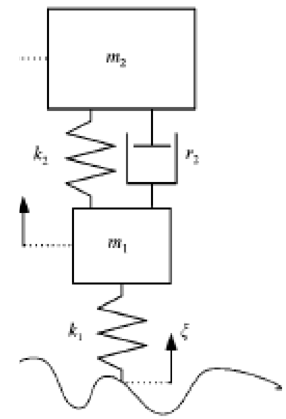
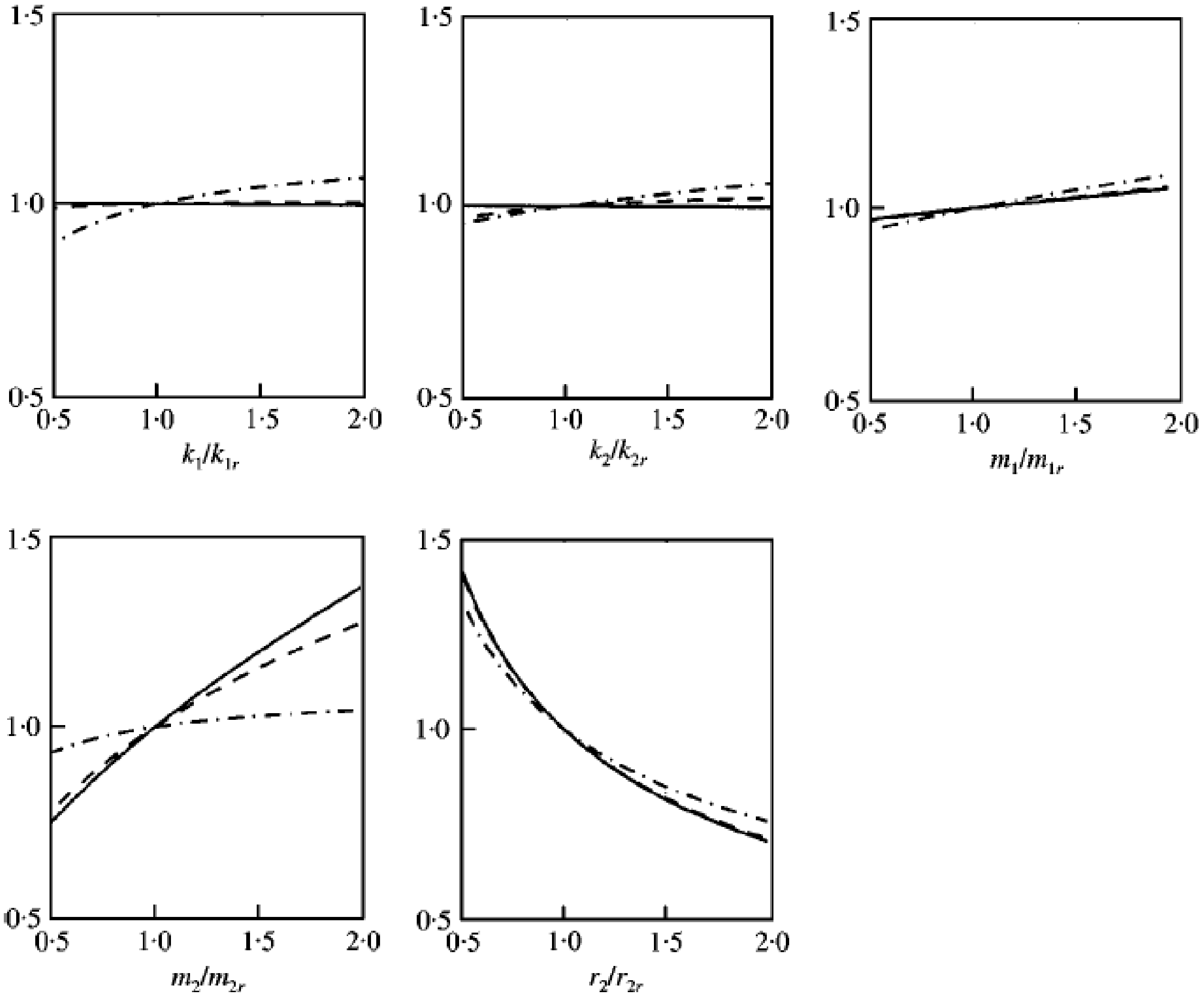


Figure 4. $\sigma_{F_z}/\sigma_{F_{zr}}$: non-dimensional standard deviation of road holding as a function of model parameters. Data of the reference vehicle in Table 1, running condition data in Table 2. Each diagram has been obtained by varying one single parameter, the other ones being constant and equal to those of the reference vehicle. – – – –, 2S-PSD: v = 10 m/s; $\cdot - \cdot - \cdot -$, 2S-PSD: v = 50 m/s; ——, 1S-PSD: any speed.

Suspensions



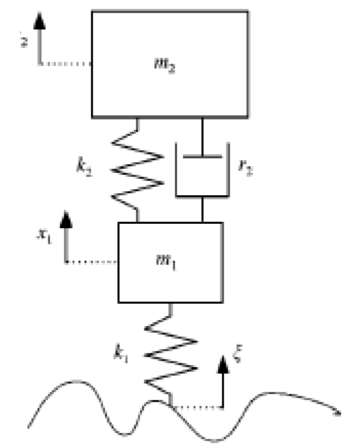


Figure 5. $\sigma_{x_2-x_1}/\sigma_{x_2-x_1r}$: non-dimensional standard deviation of working space as function of model parameters. Data of the reference vehicle in Table 1, running condition data in Table 2. Each diagram has been obtained by varying one single parameter, the other ones being constant and equal to those of the reference vehicle. ----, 2S-PSD: $v = 10$ m/s; ·-·-·-·, 2S-PSD: $v = 50$ m/s; ——, 1S-PSD: any speed.

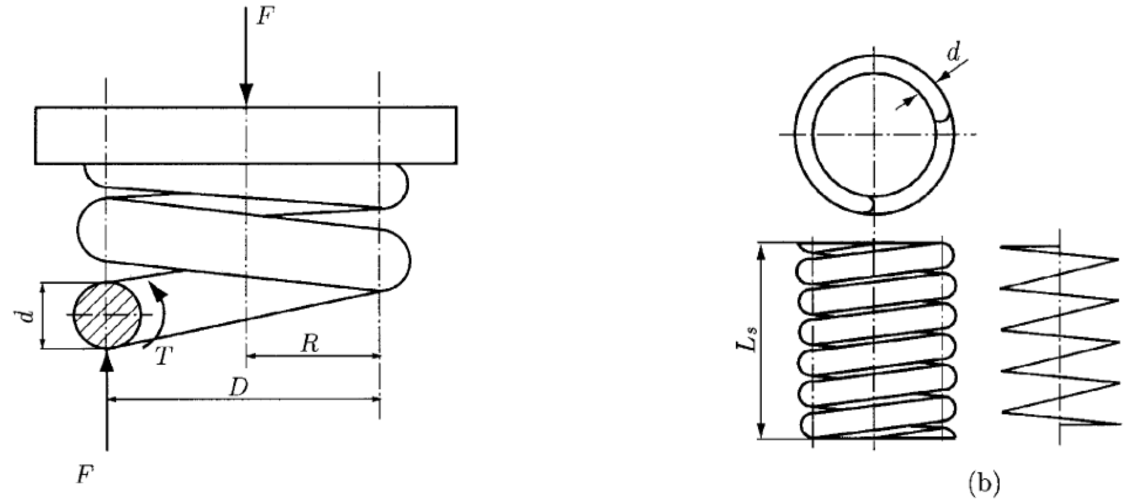


Figure 3.3

From Eq. (3.18), with the substitution $C = D/d$, the spring rate for a helical spring under an axial load is

$$k = \frac{Gd}{8C^3N}. \tag{3.22}$$

For springs in parallel having individual spring rates k_i (Fig. 3.4a), the spring rate k is

$$k = k_1 + k_2 + k_3. \tag{3.23}$$

For springs in series, with individual spring rates k_i (Fig. 3.4b), the spring rate k is

$$k = \frac{1}{\dfrac{1}{k_1} + \dfrac{1}{k_2} + \dfrac{1}{k_3}}. \tag{3.24}$$