

114 學年度四技二專第二次聯合模擬考試

土木與建築群 專業科目(一) 詳解

114-2-06-4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	D	C	A	B	A	A	C	B	A	B	D	C	D	D	B	D	B	C	C
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
A	B	A	B	C	A	B	C	C	D	A	D	B	D	C	D	D	B	A	C

1. (A) 物體所受應力
- 500 kN/m^2

$$1 \text{ lbf} = 0.454 \text{ kgf}$$

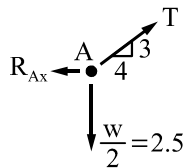
$$1 \text{ kgf} = 9.81 \text{ N}$$

$$1 \text{ in} = 2.54 \text{ cm}$$

$$\text{較 } 500 \text{ lbf/in}^2 \left(\frac{500 \times 0.454 \times 9.81}{(2.54 \times 0.01)^2} \right) = 3451655 \text{ N/m}^2$$

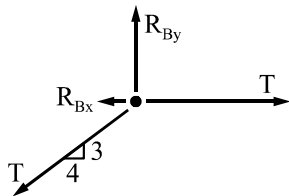
$$\div 3452 \text{ kN/m}^2 \text{ 小}$$

2. (1) 取 A 點進行分析：



$$+\uparrow \Sigma F_y = \frac{3}{5}T - 2.5 = 0, T = 4.2 \text{ kgf}$$

- (2) 取 B 點進行分析：

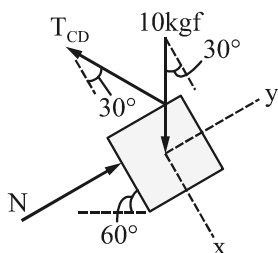


$$+\rightarrow \Sigma F_x = T - \frac{4}{5}T - R_{Bx} = 0 \Rightarrow R_{Bx} = \frac{T}{5} = 0.84 \text{ kgf}$$

$$+\uparrow \Sigma F_y = R_{By} - \frac{3}{5}T = 0 \Rightarrow R_{By} = \frac{3}{5}T = 2.5 \text{ kgf}$$

$$\Rightarrow R_B = \sqrt{(0.84)^2 + (2.5)^2} \div 2.6 \text{ kgf}$$

3. 繪箱子自由體圖，以沿斜面方向為 x，垂直斜面為 y 方向



$$\searrow + \Sigma F_x = 10 \times \cos 30^\circ - T_{CD} \cos 30^\circ = 0$$

$$\Rightarrow T_{CD} = 10 \text{ kgf}$$

$$+\nearrow \Sigma F_y = N - 10 \times \sin 30^\circ - T_{CD} \sin 30^\circ = 0$$

$$\Rightarrow N = 10 \text{ kgf}$$

4. (A) 力偶矩的方向垂直於力偶之兩力所在的平面

5. (1) 計算合力 R 大小

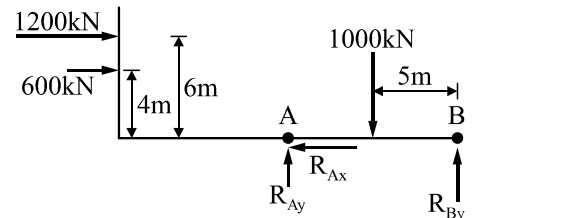
$$+\uparrow \Sigma F_y = 100 + 50 + 60 + 60 + 90 = R = 360 \text{ kN}(\uparrow)$$

- (2) 對座標原點取力矩

$$\curvearrowright + \Sigma M_O = -50 \times 10 - 60 \times 20 - 60 \times 30 - 90 \times 40 = -360 \times d \Rightarrow d = 19.7 \text{ m (在原點右側 19.7 m)}$$

6. (1) L 型橫梁自由體圖如下(將均佈力轉換成等效集中力)

對 A 點取力矩：



$$\curvearrowright + \Sigma M_A = 1200 \times 6 + 600 \times 4 + 1000 \times 5 - R_B \times 10 = 0 \Rightarrow R_B = 1460 \text{ kN}(\uparrow)$$

- (2) 力平衡分析：

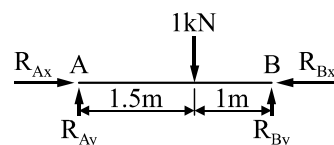
$$+\uparrow \Sigma F_y = R_{Ay} - 1000 + 1460 = 0 \Rightarrow R_{Ay} = -460 \text{ kN}(\downarrow)$$

$$+\rightarrow \Sigma F_x = 1200 + 600 - R_{Ax} = 0 \Rightarrow R_{Ax} = 1800 \text{ kN}(\leftarrow)$$

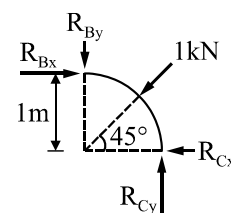
$$R_A = \sqrt{(-460)^2 + (1800)^2} \div 1858 \text{ kN}$$

7. (1) 分別繪 AB 桿、BC 桿的自由體圖如圖(a)、圖(b)

圖(a)：



圖(b)：



由圖(a)知

$$\curvearrowright + \Sigma M_A = 1 \times 1.5 - R_{By} \times 2.5 = 0 \Rightarrow R_{By} = 0.6 \text{ kN}(\uparrow)$$

$$+\rightarrow \Sigma F_x = R_{Ax} - R_{Bx} = 0, R_{Ax} = R_{Bx}$$

- (2) 由圖(b)知

$$\curvearrowright + \Sigma M_C = R_{Bx} \times 1 - 0.6 \times 1 - 1 \times 1 \cdot \sin 45^\circ = 0$$

$$\Rightarrow R_{Bx} = 1.3 \text{ kN}(\rightarrow)$$

$$+\uparrow \Sigma F_y = -0.6 + R_{Cy} - 1 \times \sin 45^\circ = 0$$

$$\Rightarrow R_{Cy} = 1.3 \text{ kN}(\uparrow)$$

$$+\rightarrow \Sigma F_x = 1.3 - 1 \times \cos 45^\circ - R_{Cx} = 0 \Rightarrow R_{Cx} = 0.6 \text{ kN}(\leftarrow)$$

$$R_C = \sqrt{(0.6)^2 + (1.3)^2} = 1.43 \text{ kN}$$

8. (1) 假設各腳的內力分別為 f_{BC} 、 f_{AC} 、 f_{OC} ，經緯儀達平衡狀態須滿足共點力系平衡：

$$\vec{f}_{BC} + \vec{f}_{AC} + \vec{f}_{OC} + \vec{w} = 0$$

(2) 列平衡方式如下：

$$\vec{BC} \left(-\frac{1}{2}, \frac{3}{2}, -\frac{1}{2}\right), \vec{AC} \left(\frac{1}{2}, \frac{3}{2}, -\frac{1}{2}\right), \vec{OC} \left(\frac{1}{2}, \frac{3}{2}, \frac{1}{2}\right)$$

$$a = \sqrt{\left(\frac{1}{2}\right)^2 + \left(\frac{3}{2}\right)^2 + \left(\frac{1}{2}\right)^2} = \frac{\sqrt{11}}{2}$$

$$\vec{f}_{BC} = \frac{1}{a} \left(-\frac{1}{2}\right) f_{BC} \vec{i} + \frac{1}{a} \left(\frac{3}{2}\right) f_{BC} \vec{j} + \frac{1}{a} \left(-\frac{1}{2}\right) f_{BC} \vec{k}$$

$$\vec{f}_{AC} = \frac{1}{a} \left(\frac{1}{2}\right) f_{AC} \vec{i} + \frac{1}{a} \left(\frac{3}{2}\right) f_{AC} \vec{j} + \frac{1}{a} \left(-\frac{1}{2}\right) f_{AC} \vec{k}$$

$$\vec{f}_{OC} = \frac{1}{a} \left(\frac{1}{2}\right) f_{OC} \vec{i} + \frac{1}{a} \left(\frac{3}{2}\right) f_{OC} \vec{j} + \frac{1}{a} \left(\frac{1}{2}\right) f_{OC} \vec{k}$$

$$\vec{w} = 0 \vec{i} + (-9) \vec{j} + 0 \vec{k}$$

(3) 由 x 、 y 、 z 三方向合力為零，解 f_{AC} 、 f_{BC} 、 f_{OC}

$$\left. \begin{aligned} \frac{1}{a} \left(-\frac{1}{2} f_{BC} + \frac{1}{2} f_{AC} + \frac{1}{2} f_{OC}\right) &= 0 \\ \frac{1}{a} \left(-\frac{1}{2} f_{BC} - \frac{1}{2} f_{AC} + \frac{1}{2} f_{OC}\right) &= 0 \end{aligned} \right\} \Rightarrow f_{AC} = 0, f_{OC} = f_{BC}$$

$$\frac{1}{a} \left(\frac{3}{2} f_{BC} + \frac{3}{2} f_{AC} + \frac{3}{2} f_{OC}\right) - 9 = 0 \Rightarrow \frac{6}{2} f_{BC} = 9a$$

$$\Rightarrow f_{BC} = 3a = 3 \times \frac{\sqrt{11}}{2} = \frac{3}{2} \sqrt{11} \text{ kgf} = f_{OC}$$

[另解]

四力對 z 軸取力矩

$$\Sigma M_z = 0, 9 \times \frac{1}{2} = R_{By} \times 1, R_{By} = \frac{9}{2}$$

$$\text{又 } \vec{BC} = \left(-\frac{1}{2}, \frac{3}{2}, -\frac{1}{2}\right)$$

$$\ell_{BC} = \sqrt{\left(-\frac{1}{2}\right)^2 + \left(\frac{3}{2}\right)^2 + \left(-\frac{1}{2}\right)^2} = \frac{\sqrt{11}}{2}$$

$$R_{By} = \frac{\frac{3}{2}}{\frac{\sqrt{11}}{2}} R_B = \frac{9}{2}$$

$$R_{By} = \frac{\cancel{3} \times \sqrt{11}}{\cancel{2} \times \cancel{2}} \times \frac{\cancel{2}}{\cancel{2}} = \frac{3\sqrt{11}}{2}$$

9. (1) 纜繩在 x 、 y 、 z 三方向之分力為 f_{BAx} 、 f_{BAy} 、 f_{BAz}

$$\vec{BA} = (150, 0, 200) - (250, 200, 0)$$

$$= (-100, -200, 200) \text{ cm} = (-1, -2, 2) \text{ m}$$

$$f_{BAx} = 200 \times \frac{-1}{\sqrt{1^2 + 2^2 + 2^2}} = \frac{-200}{3} \text{ N}$$

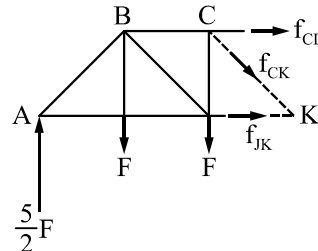
$$f_{BAy} = 200 \times \frac{-2}{\sqrt{1^2 + 2^2 + 2^2}} = \frac{-400}{3} \text{ N}$$

$$f_{BAz} = 200 \times \frac{2}{\sqrt{1^2 + 2^2 + 2^2}} = \frac{400}{3} \text{ N}$$

(2) 對 CD 之力矩 M_{CD} ：

$$+\uparrow \Sigma M_{CD} = -f_{BAz} \times (2.5 - 1) = \frac{-400}{3} \times 1.5 = -200 \text{ N}\cdot\text{m}(\downarrow)$$

10. (1) 依截面法，判斷桿件拉壓狀態：



$$+\uparrow \Sigma F_y = \frac{5}{2} F - F - F - F - f_{CK} \times \frac{1}{\sqrt{2}} = 0$$

$$\Rightarrow f_{CK} = \frac{\sqrt{2}}{2} F \text{ 為拉力桿}(+)$$

$$\curvearrowright + \Sigma M_C = \frac{5}{2} F \times 2L - F \times L - f_{JK} \times L = 0$$

$$\Rightarrow f_{JK} = 4F \text{ 為拉力桿}(+)$$

$$\curvearrowright + \Sigma M_K = \frac{5}{2} F \times 3L - F \times 2L - F \times L + f_{CD} \times L = 0$$

$$\Rightarrow f_{CD} = -4.5F \text{ 為壓力桿}(-)$$

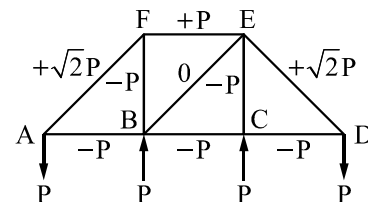
(2) 依對稱結構分析可得

f_{EK} 為拉力桿(+)

f_{KL} 為拉力桿(+)

f_{DE} 為壓力桿(-)

11. 依節點法分析桁架各桿件內力如下：

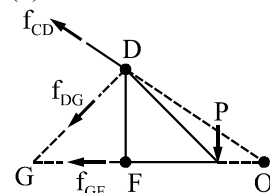


最大內力之桿件為 AF 桿、 ED 桿

最大內力為 $\sqrt{2}P \leq 1 \text{ kN}$

$$\Rightarrow P \leq \frac{1}{\sqrt{2}} \text{ kN (即 } P \text{ 力最大值為 } \frac{1}{\sqrt{2}} \text{ kN)}$$

12. (1) 截面法：



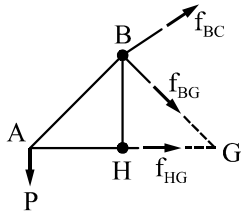
$$\textcircled{1} \text{ 由對 } O \text{ 點力矩 } \Sigma M_O = 0$$

判斷 f_{DG} 為壓力桿(-)

$$\textcircled{2} \text{ 由對 } G \text{ 點力矩 } \Sigma M_G = 0$$

判斷 f_{CD} 為拉力桿(+)

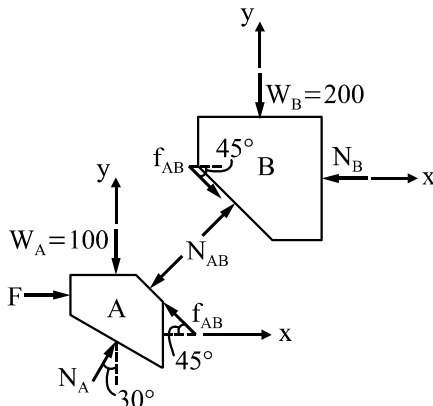
(2) 截面法：



①由對 G 點力矩 $\Sigma M_G = 0$ ，判斷 f_{BC} 為拉力桿(+)

②由對 B 點力矩 $\Sigma M_B = 0$ ，判斷 f_{HG} 為壓力桿(-)

13. (1) 繪 A、B 物體自由體圖如下， f_{AB} 為靜摩擦力



由 B 物自由體圖分析

$$\rightarrow \Sigma F_x = -N_B + N_{AB} \cdot \frac{1}{\sqrt{2}} + f_{AB} \cdot \frac{1}{\sqrt{2}} = 0$$

$$+\uparrow \Sigma F_y = -200 + N_{AB} \cdot \frac{1}{\sqrt{2}} - f_{AB} \cdot \frac{1}{\sqrt{2}} = 0$$

$$f_{AB} = \mu \cdot N_{AB} = 0.2 N_{AB}$$

$$\Rightarrow N_{AB} = 250\sqrt{2} \text{ N}$$

$$N_B = 300 \text{ N}$$

$$f_{AB} = 50\sqrt{2} \text{ N}$$

(2) 由 A 物自由體圖分析

$$\rightarrow \Sigma F_x = F + N_A \cdot \frac{1}{2} - 50\sqrt{2} \cdot \frac{1}{\sqrt{2}} - 250\sqrt{2} \cdot \frac{1}{\sqrt{2}} = 0$$

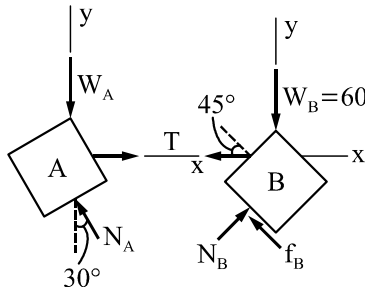
$$+\uparrow \Sigma F_y = -100 + N_A \cdot \frac{\sqrt{3}}{2} + 50\sqrt{2} \cdot \frac{1}{\sqrt{2}} - 250\sqrt{2} \cdot \frac{1}{\sqrt{2}} = 0$$

$$N_A = 300 \cdot \frac{2}{\sqrt{3}} = \frac{600}{\sqrt{3}} \text{ N}$$

$$F = 300 - \frac{300}{\sqrt{3}} = 300(1 - \frac{1}{\sqrt{3}}) = 126.8 \text{ N}$$

14. (1) 繪 A、B 物體之自由體圖

由 B 物體平衡分析



$$\rightarrow \Sigma F_x = -T + N_B \cdot \frac{1}{\sqrt{2}} - f_B \cdot \frac{1}{\sqrt{2}} = 0$$

$$+\uparrow \Sigma F_y = -60 + N_B \cdot \frac{1}{\sqrt{2}} + f_B \cdot \frac{1}{\sqrt{2}} = 0$$

$$f_B = 0.1 N_B \Rightarrow N_B = \frac{600}{11} \sqrt{2}$$

$$T = \frac{600}{11} \sqrt{2} \cdot \frac{1}{\sqrt{2}} - 0.1 \cdot \frac{600}{11} \sqrt{2} \cdot \frac{1}{\sqrt{2}} = 0 \Rightarrow T \doteq 49 \text{ kgf}$$

(2) 由 A 物體平衡分析

$$\rightarrow \Sigma F_x = T - N_A \cdot \frac{1}{2} = 0 \Rightarrow N_A = 98 \text{ kgf}$$

$$+\uparrow \Sigma F_y = -W_A + N_A \cdot \frac{\sqrt{3}}{2} = 0$$

$$\Rightarrow W_A = 49\sqrt{3} \text{ kgf} \doteq 84.9 \text{ kgf}$$

15. (1) 重心 \bar{x}

$$\bar{x} = \frac{6 \times 3 + 6\sqrt{2} \times 3 + 6 \times 3 + 6 \times 6 + 6\sqrt{2} \times 9 + 6 \times 9 + 6 \times 0}{6 + 6\sqrt{2} + 6 + 6 + 6\sqrt{2} + 6 + 6}$$

$$= \frac{126 + 72\sqrt{2}}{30 + 12\sqrt{2}} = \frac{21 + 12\sqrt{2}}{5 + 2\sqrt{2}} = 4.85 \text{ m}$$

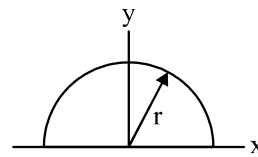
(2) 重心 \bar{y}

$$\bar{y} = \frac{6\sqrt{2} \times 3 + 6 \times 6 + 6 \times 3 + 6\sqrt{2} \times 3 + 6 \times 3}{30 + 12\sqrt{2}} = \frac{72 + 36\sqrt{2}}{30 + 12\sqrt{2}}$$

$$= \frac{12 + 6\sqrt{2}}{5 + 2\sqrt{2}} = \frac{36 + 6\sqrt{2}}{17} = 2.62 \text{ m}$$

16. 由半圓形慣性矩

$$I_x = \frac{1}{2} \left(\frac{\pi d^4}{64} \right) = \frac{\pi (2r)^4}{128} = \frac{\pi r^4}{8} = I_y$$



圖(十四)上之半圓環形

$$I_x = \frac{1}{8} \pi (16^4 - 8^4) = 7680\pi = I_y$$

17. 對 x 軸慣性矩 I_x

$$I_x = \frac{1}{3} \times 12 \times (L+2)^3 - \left[\frac{1}{12} \times 10 \times L^3 + (L \times 10) \times \left(1 + \frac{L}{2}\right)^2 \right]$$

$$\text{若 } L = 8 \Rightarrow I_x = \frac{1}{3} \times 12 \times 10^3 - \left[\frac{1}{12} \times 10 \times 8^3 + (80) \times (5)^2 \right]$$

$$\doteq 4000 - 2427 = 1573 \text{ cm}^4 \cdots \text{最小 } I_x$$

若 $L = 18$

$$\Rightarrow I_x = \frac{1}{3} \times 12 \times 20^3 - \left[\frac{1}{12} \times 10 \times 18^3 + (18 \times 10) \times (1+9)^2 \right]$$

$$\doteq 32000 - 22860 = 9140 \text{ cm}^4 \cdots \text{最大 } I_x$$

18. 依據廣義虎克定律

$$\varepsilon_z = \frac{-1.2 \times 10^{-3}}{2} = -0.6 \times 10^{-3} = \frac{-\sigma_0}{E} (1 - 2\nu)$$

$$= \frac{-\sigma_0}{E} (1 - 2 \times 0.2) \Rightarrow \frac{\sigma_0}{E} = 10^{-3}$$

$$\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z = -3 \times \frac{\sigma_0}{E} (1 - 2\nu)$$

$$= -3 \times 10^{-3} \times (1 - 2 \times 0.2) = -1.8 \times 10^{-3}$$

19. (1) 混凝土受壓造成之軸向應變 ε_1

$$\varepsilon_1 = \frac{\delta_1}{30} = \frac{\left(\frac{P \times L}{AE}\right)}{30} = \frac{\left(\frac{30000 \times 30}{\pi \left(\frac{15}{2}\right)^2 \times 200000}\right)}{30} = 8.48 \times 10^{-4}$$

- (2) 橫向應變 ε_T

$$\varepsilon_T = \frac{0.0045}{15} = 0.0003$$

- (3) 蒲松比

$$\nu = \frac{\varepsilon_T}{\varepsilon_1} = \frac{0.0003}{8.48 \times 10^{-4}} \div 0.35$$

20. A 構件伸長量 δ_A ; B 構件伸長量 δ_B

$$\delta_A = \frac{P \cdot L_1}{A_1 E_1}, \delta_B = \frac{P \cdot L_2}{A_2 E_2}$$

$$\text{又 } \delta_A = \delta_B, A_1 = \frac{A_2}{2}, E_2 = 2E_1 \text{ 代入}$$

$$\frac{P \cdot L_1}{\left(\frac{1}{2} A_2\right) \left(\frac{1}{2} E_2\right)} = \frac{P \cdot L_2}{A_2 E_2} \Rightarrow \frac{L_1}{\frac{1}{4} A_2 E_2} = \frac{L_2}{A_2 E_2} \Rightarrow \frac{L_1}{L_2} = \frac{1}{4}$$

21. (A) 試驗經費及材料的單價分析並非試驗報告應主動揭露的部分
 22. (B) 條形圖(直條圖)主要是要方便試驗者看出各個應變數之間的差異;而 x-y 散佈圖可了解自變數與應變數間的關係,利用迴歸方程式來進行數據之判讀
 23. (A) 氫氧化鈣 $\text{Ca}(\text{OH})_2$ 非高爐水泥的成分,而是水泥水化後的產物
 24. 卜特蘭水泥的化合物的性質

性質	化合物			
	C_2S	C_3S	C_3A	C_4AF
水化熱量	62 卡/克	120 卡/克	207 卡/克	100 卡/克

25. (C) 水泥經過長期儲存會與空氣中的水分起風化作用造成水泥密度下降,若低於 3.05 g/cm^3 代表風化相當嚴重;但風化水泥密度不至於低到 $2.85 \sim 2.90 \text{ g/cm}^3$
 26. (B) 石膏可以延長水泥凝結時間,若含量過多會使混凝土膨脹;若含量太少會縮短水泥凝結時間
 (C) 游離石灰會有遲緩水化現象,造成水泥健性不良
 (D) 水泥中氧化鎂含量過多,容易造成遲緩水化現象,導致水泥健性不良
 27. (A) 篩分析法 75% 太低,篩餘量應降至 10% 以下
 (C) 氣透儀試驗出比表面積需不小於 $2600 \text{ cm}^2/\text{g}$ (依據 CNS61 規定)
 (D) 普通卜特蘭水泥細度約為 $2800 \sim 3600 \text{ cm}^2/\text{g}$, $4000 \text{ cm}^2/\text{g}$ 以上乃是早強水泥細度的範圍,水泥愈細水化速率愈快
 28. (C) 物理健性試驗乃將粒料浸入硫酸鈉飽和溶液浸泡 16~18 小時,然後取出烘乾,降溫後再浸入溶液中,然後烘乾,如是反覆循環 5 次,計算其重量損失百分率
 30. CNS3090 規定新拌混凝土中最大水溶性氯離子含量,鋼筋混凝土及預力混凝土均不得超過 0.15 kg/m^3

31. ① 混凝土拌和時,若拌和水量太低(水灰比小於 0.42),則拌和水不能充分供應水泥水化作用所需之水量,此時未水化的水泥核心會將鄰近水化產物內或孔隙內之水吸乾,以便持續進行水化作用,造成混凝土體積收縮;此種「自乾現象」稱為自身體積收縮或「自體收縮」。因此水灰比應高於 0.42,才不會產生自體收縮現象
 ② 混凝土若長時間浸泡於水中,則水泥水化過程中之水分可能由外來水取代,致使水泥生成物吸過多水造成混凝土微量膨脹
 ③ 不受束制之混凝土會隨溫度的升降而膨脹或收縮,溫度升高混凝土會膨脹
 ④ 混凝土暴露在含有二氧化碳之空氣中,則重量增加,同時發生碳化收縮
 ⑤ 水泥中的氧化鎂(MgO)或硫酸鹽含量太高,凝結時體積膨脹造成混凝土龜裂
 32. ① 氯化鈣是最常用的速凝劑
 ② 混凝土添加氯化鈣最大用量不得超過混凝土中水泥重量的 2%,超過 2% 以上時效果不大,且可能產生急凝現象而降低強度
 34. (D) 若擠出後要維持強度,應選擇具低坍度特性的材料
 35. (C) 德州紅為花崗石類耐候性較大理石類佳
 36. (D) 硬石與半硬石的強度以 500 kgf/cm^2 為分界
 37. $\text{nm} = 10^{-9} \text{ m} = 10^{-3} \mu\text{m} = 10^{-7} \text{ cm}$
 39. (B) 一般而言,針葉樹原木含水量較闊葉樹多
 (C) 心材的含水量較邊材的含水量少
 (D) 木材內所含水分主要為游離水,約佔木材全乾重量的 60%