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151ENG031022

Civil Engineering

$$T_1 + T_2 - 2T_3 + T_4 + 3T_5 - T_6 = 4$$

$$2T_1 - T_2 + T_3 + 2T_4 + T_5 - 3T_6 = 20$$

$$T_1 + 3T_2 - 3T_3 - T_4 + 2T_5 + T_6 = -15$$

$$5T_1 + 2T_2 - T_3 - T_4 + 2T_5 + T_6 = -3$$

$$-3T_1 - T_2 + 2T_3 + 3T_4 + T_5 + 3T_6 = 16$$

$$4T_1 + 3T_2 + T_3 - 6T_4 - 3T_5 - 2T_6 = -27$$

Transforming the equations into matrix

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 2 & -1 & -1 & 2 & 1 & -3 \\ 1 & 3 & -3 & -1 & 2 & 1 \\ 5 & 2 & -1 & -1 & 2 & 1 \\ -3 & -1 & 2 & 3 & 1 & 3 \\ 4 & 3 & 1 & -6 & -3 & -2 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{bmatrix} = \begin{bmatrix} 4 \\ 20 \\ -15 \\ -3 \\ 16 \\ -27 \end{bmatrix}$$

Using a factor of (2) to multiply Row 1 and subtract Row 2

$$2 - (2)(1), -1 - (2)(1), -1 - (2)(-2), 2 - (2)(1), 1 - (2)(3), (-3) - (2)(-1) \quad 20 - (2)(4)$$

$$0 \quad -3 \quad 5 \quad 0 \quad -5 \quad -1 \quad 12$$

Using a factor (1) to multiply Row 1 and subtract Row 3

$$1 - (1)(1), 3 - (1)(1), -3 - (1)(-2), -1 - (1)(1), 2 - (1)(3), 1 - (1)(-1), -15 - (1)(4)$$

$$0 \quad 2 \quad -1 \quad -2 \quad -1 \quad 2 \quad -19$$

Using a factor (5) to multiply Row 1 and subtract Row 4

$$5 - (5)(1), 2 - (5)(1), -1 - (5)(-2), -1 - (5)(1), 2 - (5)(3), 1 - (5)(-1), -3 - (5)(4)$$

$$0 \quad -3 \quad 9 \quad -6 \quad -13 \quad 6 \quad -23$$

Using a factor (-3) to multiply Row 1 and subtract Row 5

$$-3 - (-3)(1), -1 - (-3)(1), 2 - (-3)(-2), 3 - (-3)(1), 1 - (-3)(3), 3 - (-3)(-1), 16 - (-3)(4)$$

$$0 \quad 2 \quad -4 \quad 6 \quad 10 \quad 0 \quad 28$$

Using a factor (4) to multiply Row 1 and subtract Row 6

$$4 - (4)(1), 3 - (4)(1), 1 - (4)(-2), -6 - (4)(1), -3 - (4)(3), -2 - (4)(-1), -27 - (4)(4)$$

$$0 \quad -1 \quad 9 \quad -10 \quad -15 \quad 2 \quad -43$$

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1	1	-2	1	3	-1	T_1	4
0	-3	5	0	-5	-1	T_2	12
0	2	-1	-2	-1	2	T_3	-19
0	-3	9	-6	-13	6	T_4	-23
0	2	-4	6	10	0	T_5	28
0	-1	9	-10	-15	2	T_6	-43

Using a factor of $(-2/3)$ to multiply Row 1 and subtract from Row 2
 $2 - (-2/3)(3)$, $-1 - (-2/3)(5)$, $-2 - (-2/3)(0)$, $-1 - (-2/3)(-5)$, $2 - (-2/3)(-1)$, $-19 - (-2/3)(12)$

0 2.3333 -2 -4.3333 1.3333 -11

Using a factor of (1) to multiply Row 2 and subtract Row 4
 $-3 - (1)(-3)$, $9 - (1)(5)$, $-6 - (1)(0)$, $-13 - (1)(-5)$, $6 - (1)(-1)$, $-23 - (1)(12)$

0 4 -6 -8 7 -35

Using a factor of $(-2/3)$ to multiply Row 2 and subtract Row 5
 $2 - (-2/3)(-3)$, $-4 - (-2/3)(5)$, $6 - (-2/3)(0)$, $10 - (-2/3)(-5)$, $0 - (-2/3)(-1)$, $28 - (-2/3)(12)$

0 -0.6666 6 6.6666 -0.6666 36

Using a factor of $(1/3)$ to multiply Row 2 and subtract Row 6
 $-1 - (1/3)(-3)$, $9 - (1/3)(5)$, $-10 - (1/3)(0)$, $-15 - (1/3)(-5)$, $2 - (1/3)(-1)$, $-43 - (1/3)(12)$

0 7.9333 -10 -13.3333 2.3333 -47

1	1	-2	1	3	-1	T_1	4
0	-3	5	0	-5	-1	T_2	12
0	0	2.3333	-2	-4.3333	1.3333	T_3	-11
0	0	4	-6	-8	7	T_4	-35
0	0	-0.6666	6	6.6666	-0.6666	T_5	36
0	0	7.9333	-10	-13.3333	2.3333	T_6	-47

Using a factor of $(4/2.3333)$ to multiply Row 3 and subtract Row 4
 $4 - (4/2.3333)(2.3333)$, $-6 - (4/2.3333)(-2)$, $-8 - (4/2.3333)(-4.3333)$, $7 - (4/2.3333)(1.3333)$, $-35 - (4/2.3333)(-11)$

0 -2.5714 -0.57143

4.7142 -16.1429

Using a factor of (0.2856) and multiplying by Row 3 and subtracting Row 5

$$\begin{array}{r} -0.6666 - (-0.2856)(1.3333)' \\ -0.28571 \end{array} \quad \begin{array}{r} 5.4285 \\ 36 - (-0.2856)(-11) \end{array}$$

$$7.3333 - (3.42)(2.3333)', -10 - (3.1428)(-2)', -13.3333(3.1428)(-4.3333)$$

$$\begin{array}{r} 2.3333 - (3.1428)(1.3333)', -3.71429 \quad 0.28571 \\ -1.85714 \quad -47 - (3.428)(-11) \\ -12.4286 \end{array}$$

1	1	-2	1	3	-1	T_1	↑
0	-3	5	0	-5	-1	T_2	12
0	0	2.3333	-2	-4.3333	1.3333	T_3	-11
0	0	0	-2.571	-0.5714	4.7142	T_4	-16.1429
0	0	0	5.4285	5.4285	-0.2857	T_5	32.8571
0	0	0	-3.7142	0.2857	-1.8571	T_6	-12.4286

~~5. 4285 - (-2.1114) - (-2.571)~~ to multiply Row 4 and subtract from Rows
 5. 4285 - (-2.1114) - (-2.571), 5. 4285 - (-2.1114) - (-0.5714);
 0 4.2222

$$-0.2857 - (-2.114)(4.7142) \quad -32.8571 - (-2.114)(16.1429)$$

$$9.6666 \quad 1.2222$$

using a factor of $(-3.7142/2.570)$ to multiply rows and
divide rows

$$-3.9142 - (1.4446)(-2.571)^1, 0.2857 \cdot (1.4446)(-6.5714)^7,$$

$$-1.8571 - (1.4446)(4.7142) \quad -12.4286 - (1.4446)(-16.1429)$$

$$-8.6666 \quad 10.8888$$

15/EN903/022

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 2.3333 & -2 & -4.3333 & 1.3333 \\ 0 & 0 & 0 & -2.5714 & -0.5714 & 4.7142 \\ 0 & 0 & 0 & 0 & 4.2222 & 9.6666 \\ 0 & 0 & 0 & 0 & 1.1111 & -8.6666 \end{bmatrix} \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{matrix} = \begin{matrix} 4 \\ 12 \\ -11 \\ -16.1429 \\ -1.2222 \\ 10.8888 \end{matrix}$$

Using a factor of (1.1111 / 4.2222) to multiply Row 5 and subtract Row 6

$$1.1111 - (0.263)(4.2222), \quad -8.6666 - (0.263)(9.6666),$$

$$10.8888 - (0.263)(1.2222),$$

$$11.2105$$

$$\begin{bmatrix} 1 & 1 & -2 & 1 & 3 & -1 \\ 0 & -3 & 5 & 0 & -5 & -1 \\ 0 & 0 & 2.3333 & -2 & -4.3333 & 1.3333 \\ 0 & 0 & 0 & -2.5714 & -0.5714 & 4.7142 \\ 0 & 0 & 0 & 0 & 4.2222 & 9.6666 \\ 0 & 0 & 0 & 0 & 0 & -11.2105 \end{bmatrix} \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{matrix} = \begin{matrix} 4 \\ 12 \\ -11 \\ -16.1429 \\ -1.2222 \\ 11.2105 \end{matrix}$$

using back substitution.

$$-11.2105 T_6 = 11.2105$$

$$T_6 = \frac{11.2105}{-11.2105} = -1$$

$$4.2222 T_5 + 9.6666 T_6 = -1.2222$$

$$T_5 = \frac{-1.2222 - 9.6666(-1)}{4.2222} = 2$$

$$2.5714 T_4 - 0.5714 T_5 + 4.7142 T_6 = -16.1429$$

$$T_4 = \frac{-16.1429 - 4.7142(-1) + 0.5714(2)}{-2.5714} = 4$$

$$2.3333 T_3 - 2 T_4 - 4.3333 T_5 + 1.3333 T_6 = -11$$

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15/EN1903/022

$$T_3 = \frac{-11 - 1.3333(-1) + 4.3333(2) + 2(4)}{2.3333} = 3$$

$$-3T_2 + 5T_3 + 6T_4 - 5T_5 - T_6 = 13$$

$$T_2 = \frac{12 + (-1) + 5(2) - 5(3)}{-3} = -2$$

$$T_1 + T_2 - 2T_3 + T_4 + 3T_5 - T_6 = 4$$

$$T_1 = \frac{4 + (-1) - 3(-2) - 4 + 2(3) - (-2)}{1} = 1$$

therefore

$$T_1 = 1$$

$$T_2 = -2$$

$$T_3 = 3$$

$$T_4 = 4$$

$$T_5 = 2$$

$$T_6 = -1$$