# Report No. 11-225

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# STRUCTURAL CALCULATIONS

| | |
|---|---|
| **Project:** | **Floating Foundation Deck System**<br>**To be read in conjunction with our drawing number:**<br>**Q11-225-01** |
| **Client:** | **Evolve Composites Pty Ltd**<br>**P O Box 2077**<br>**CLONTARF 4019** |
| **Prepared By:** | **David H Lao** |
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| **Dated:** | **July 15, 2011** |

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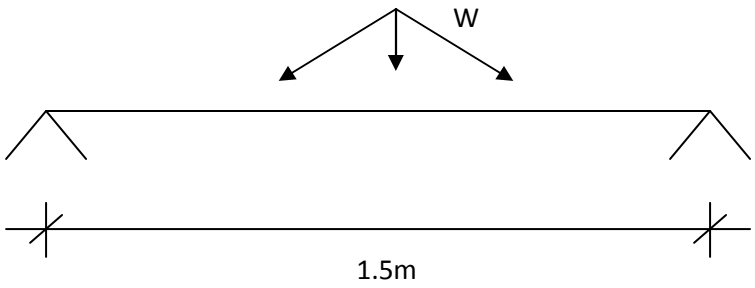
## OPTION 1. FLOOR JOISTS AT 450 CENTRES, LESS THAN 1M OFF GROUND

### A. DESIGN FLOOR JOISTS




$G = 0.25kPa$ $Q = 1.5kPa$

Floor Joist Space $= 450mm$

Strength Limit State Combination Load $W = 1.2G + 1.5Q$

$= [(1.2)(0.25) + (1.5)(1.5)](0.45)$

$= 1.15kN/m$

$M^* = WL^2/8 = (1.15)(1.5)^2/8 = 0.32kNm$

#### CHECK FLOOR JOIST BENDING STRENGTH

(Bending in Strength Limit State Capacity Check)

- For 120 x 45 MGP10

$f'_b = 17MPa$

$E = 10{,}000Mpa$

$I = bd^3/12 = (45)(120)^3/12 = 6.48 \times 10^6 mm^4$

$Z = bd^2/6 = (45)(120)^2/6 = 108 \times 10^3 mm^3$

$\Phi M \geq M^*$

$\Phi M = \Phi k_1 k_4 k_6 k_9 k_{11} k_{12} f'_b Z$

$= (0.9)(0.94)(1)(1)(1)(1)(1)(17)(108)$

$= 1.55kNm > M^*\ (0.32kNm)$ $\therefore$ **OK**

## CHECK FLOOR JOIST DEFLECTION

(Serviceability)

$$W = G + 0.7Q$$
$$= [(0.25) + (0.7)(1.5)](0.45)$$
$$= 0.59 \text{ kN/m}$$

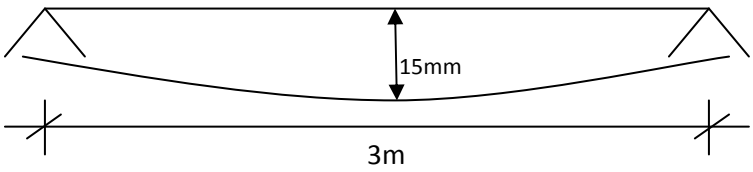
$\Delta = 5WL^4/384EI = (5)(0.78)(1500)^4/(384)(10000)(6.48 \times 10^6) = 0.6\text{mm}$

Limit $\Delta_{max} = L/300 = 1500/300 = 5\text{mm}$ $\Delta < \Delta_{max}$ **∴ OK**

## CHECK FLOOR JOIST BENDING STRENGTH AT SPAN = 3M

(Strength Limit State Check)

- To accommodate the case where a central support block settles.




$M^* = WL^2/8 = (1.15)(3)^2/8 = 1.29\text{kNm}$

$\Phi M = 1.55\text{kNm} > M^*$ **∴ OK**

## CALCULATE FLOOR JOIST DEFLECTION AT MID SPAN FOR 3M LENGTH

(Strength Limit State)

- Assume centre support block settled at 15mm

$$\Delta_{ult} = 5WL^4/385EI$$
$$= (5)(1.15)(3000)^4/(385)(1 \times 10^4)(6.48 \times 10^6)$$
$$= 18.7\text{mm}$$

∴ Floor Joist is OK if mid support block is settled $< 15$mm

Hence Floor Joists are strong enough to span 3m under the strength limit state and able to deflect to 18.7mm.

## B. DESIGN DECKING

### CHECK DECKING BENDING STRENGTH

(Strength Limit State)

Decking Span = 450mm  Load Width = 100mm

- For 90 x 22 Pine

$f_b = 14MPa$
$E = 6900Mpa$
$I = bd^3/12 = (90)(22)^3/12 = 7.99 \times 10^4$
$Z_c = bd^2/6 = (90)(22)^2/6 = 7260$

$$W = 1.2G + 1.5Q$$
$$= [(1.2)(0.25) + (1.5)(1.5)](0.1)$$
$$= 0.26kN/m$$

$M^* = WL^2/8 = (0.26)(0.45)^2/8 = 0.006kNm$

$\Phi M = \Phi k_1 k_4 k_6 k_9 k_{11} k_{12} f_b Z$
$= (0.9)(0.94)(14)(7260)$
$= 0.086kNm > M^*\ (0.006kNm)$  **∴ OK**

### CHECK DECKING DEFLECTION

(Serviceability)

$$W = G + 0.7Q$$
$$= [(0.25) + (0.7)(1.5)](0.1)$$
$$= 0.13\ kN/m$$

$\Delta = 5WL^4/384EI = (5)(0.13)(450)^4/(384)(6900)(7.99 \times 10^4) = 0.13mm$

Limit $\Delta_{max} = L/300 = 450/300 = 1.5mm$  $\Delta < \Delta_{max}$  **∴ OK**

## CHECK DECKING MAX DEFLECTION IF MID SUPPORT BLOCK SETTLED

(Strength Limit State)

$\Phi M = 0.086$ kNm

$W = 8\Phi M/L^2 = (8)(0.086)/1.2^2 = 0.48$kN/m

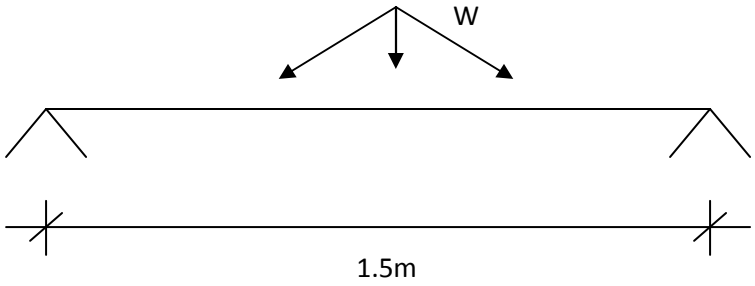
$\Delta_{able} = 5WL^4/384EI = (5)(0.48)(1200)^4/(384)(6900)(7.99 \times 10^4)$
$= 23.5\text{mm} < 15\text{mm}\ \Delta_{allow}$

$\therefore$ Decking is OK if mid support is settled $< 15$mm

Hence under the strength limit state, deckings are strong enough to span 900mm at 23.5mm deflection.

## OPTION 2. FLOOR JOISTS AT 600 CENTRES, LESS THAN 1M OFF GROUND

### A. DESIGN FLOOR JOISTS




$G = 0.25kPa$ $Q = 1.5kPa$

Floor Joist Space $= 600mm$

Strength Limit State Combination Load $W = 1.2G + 1.5Q$
$= [(1.2)(0.25) + (1.5)(1.5)](0.6)$
$= 1.53kN/m$

$M^* = WL^2/8 = (1.53)(1.5)^2/8 = 0.43kNm$

#### CHECK FLOOR JOIST BENDING STRENGTH

(Bending in Strength Limit State Capacity Check)

- For 140 x 45 MGP10

$f'_b = 17MPa$
$E = 10{,}000Mpa$
$I = bd^3/12 = (45)(140)^3/12 = 10.29 \times 10^6 mm^4$
$Z = bd^2/6 = (45)(140)^2/6 = 147 \times 10^3 mm^3$

$\Phi M \geq M^*$

$\Phi M = \Phi k_1 k_4 k_6 k_9 k_{11} k_{12} f'_b Z$
$= (0.9)(0.94)(1)(1)(1)(1)(1)(17)(147)$
$= 2.11kNm > M^*\ (0.43kNm)$ $\therefore$ **OK**

## CHECK FLOOR JOIST DEFLECTION

(Serviceability)

$$W = G + 0.7Q$$
$$= [(0.25) + (0.7)(1.5)](0.6)$$
$$= 0.78\ \text{kN/m}$$

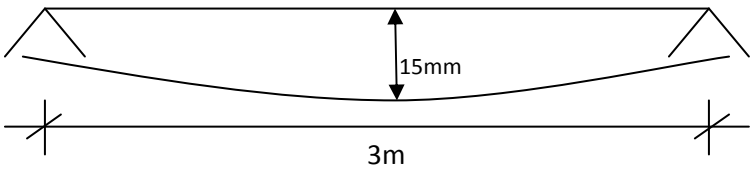
$\Delta = 5WL^4/384EI = (5)(0.78)(1500)^4/(384)(10000)(10.29 \times 10^6) = 0.5\text{mm}$

Limit $\Delta_{max} = L/300 = 1500/300 = 5\text{mm}$ $\Delta < \Delta_{max}$ $\therefore$ **OK**

## CHECK FLOOR JOIST BENDING STRENGTH AT SPAN = 3M

(Strength Limit State Check)

- To accommodate the case where a central support block settles.




$M^* = WL^2/8 = (1.53)(3)^2/8 = 1.72\text{kNm}$

$\Phi M = 2.11\text{kNm} > M^*$ $\therefore$ **OK**

## CALCULATE FLOOR JOIST DEFLECTION AT MID SPAN FOR 3M LENGTH

(Strength Limit State)

- Assume centre support block settled at 15mm

$$\Delta_{ult} = 5WL^4/385EI$$
$$= (5)(1.53)(3000)^4/(385)(1 \times 10^4)(10.29 \times 10^6)$$
$$= 15.6\text{mm}$$

$\therefore$ Floor Joist is OK if mid support block is settled $< 15$mm

Hence Floor Joists are strong enough to support 3m span under the strength limit state and able to deflect to 15.7mm.

## B. DESIGN DECKING

### CHECK DECKING BENDING STRENGTH

(Strength Limit State)

Decking Span = 600mm  Load Width = 100mm

- For 90 x 35Pine

$f_b = 14MPa$
$E = 6900Mpa$
$I = bd^3/12 = (90)(35)^3/12 = 32.1 \times 10^4$
$Z_c = bd^2/6 = (90)(35)^2/6 = 18375$

$$W = 1.2G + 1.5Q$$
$$= [(1.2)(0.25) + (1.5)(1.5)](0.1)$$
$$= 0.26kN/m$$

$M^* = WL^2/8 = (0.26)(0.6)^2/8 = 0.011kNm$

$\Phi M = \Phi k_1 k_4 k_6 k_9 k_{11} k_{12} f_b Z$
$= (0.9)(0.94)(14)(7260)$
$= 0.23kNm > M^* (0.011kNm)$  **∴ OK**

### CHECK DECKING DEFLECTION

(Serviceability)

$$W = G + 0.7Q$$
$$= [(0.25) + (0.7)(1.5)](0.1)$$
$$= 0.13\ kN/m$$

$\Delta = 5WL^4/384EI = (5)(0.13)(600)^4/(384)(6900)(32.1 \times 10^4) = 0.1mm$

Limit $\Delta_{max} = L/300 = 600/300 = 2mm$  $\Delta < \Delta_{max}$  **∴ OK**

## CHECK DECKING MAX DEFLECTION IF MID SUPPORT BLOCK SETTLED

(Strength Limit State)

$\Phi M = 0.23$ kNm

$W = 8\Phi M/L^2 = (8)(0.23)/1.2^2 = 1.28 kN/m$

$\Delta_{able} = 5WL^4/384EI = (5)(1.28)(1.2)^4/(384)(6900)(32.1 \times 10^4) = 15.6mm < 15mm\ \Delta_{allow}$

$\therefore$ Decking is OK if mid support is settled $< 15mm$

Hence under the strength limit state, deckings are strong enough to span 1200mm at 15.6 deflection.