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Job Title: Fodder Barn at Stone. Date: 12-4-2020 Sheet No.1

| Loadings: | Dead | Super | Total |
|---|---|---|---|
| Floored truss: | | | |
| tiles and battens | 0.6 kN/m2 | | |
| rafters | 0.1 kN/m2 | 0.75kN/m2 | |
| services | 0.1 kN/m2 | | |
| floor joists | 0.15kN/m2 | 1.5 kN/m2 | |
| board and finish | 0.3 kN/m2 | | |
| plasterboard | 0.3 kN/m2 | | |
| Total | 1.55kN/m2 | 2.25kN/m2 | 2.1 kN/m2 |
| External wall: | | | |
| Int. skin 215mm block | 3.87kN/m2 | | |
| Ext. skin 100mm block | 1.8 kN/m2 | | |
| render | 0.3 kN/m2 | | |
| plaster | 0.3 kN/m2 | | |
| Total | 6.27kN/m2 | | |

Steel beam over Grd. Floor openings: Span 4.5m
Load from floored truss = 1.55 x 2.5 = 3.88kN/m Dead = 2.25 x 2.5 = 5.63kN/m Super

Use 203 x 133 x 30kg UB as calculation attached.

Padstone design:
Try Travis Perkins Supreme 50N/mm2 padstone 380mm x 215mm wide.
Design load = 33.44kN; Shear perimeter = 400mm; vc = 0.8N/mm2
Depth of padstone required = 33440/400 x 0.8 = 105mm

Use 380mm long x 215mm wide x 140mm thick mass concrete Travis Perkins Supreme padstone each end of beam. Note: Beams to have minimum of 200mm bearing on to padstone at each end.

Check wall loading:
Check 215mm internal skin of cavity block pier x 900mm wide x 2.3m high.
eff.thickness = 215mm; Slenderness ratio = 11; B = 0.97; Ym = 3.5
Walls/piers of less than 0.2m2 to multiply allowable compress stress by (0.7 + 1.5A) = 0.99
Loading: Beams = 44.14kN; Factored = 66.88kN
Int. skin of pier = 3.87 x 0.9 x 2.3 = 8.01kN x 1.4 = 11.22kN
Total = 52.15kN = 78.10kN
Ext. skin of pier = 1.8 x 0.9 x 2.3 = 3.73kN x 1.4 = 5.22kN
Total = 55.88kN = 83.32kN
Actual compress. stress on int. skin of wall = 78100 x 3.5/900 x 215 = 1.4N/mm2
Try 7N/mm2 block in type 3 mortar fc = 6.4N/mm2
Allowable comp. stress = 6.4 x 0.97 x 0.99 = 6.1N/mm2 > 1.4N/mm2

Cavity wall to be constructed with 215mm internal skin of 7N/mm2 block in type 3 mortar.

Check footing under 900mm pier i.e. 600mm wide x 225mm deep acting over 1.15m length.
Ground pressure = 55.88/0.6 x 1.15 = 81kN/m2

Soil at bearing level to be proven suitable.

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Site: Fodder Barn, Stone.
Job:
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**Beam: Beams over Grd. Floor openings** **Span: 4.5 m.**

| | | Load name | Loading w1 | Start x1 | Loading w2 | End x2 | R1comp | R2comp |
|---|---|---|---|---|---|---|---|---|
| U | D | o.w. | 0.3 | 0 | | L | 0.68 | 0.68 |
| U | D | Floored roof truss dead load | 3.88 | 0 | | L | 8.73 | 8.73 |
| U | L | Floored roof truss super load | 5.63 | 0 | | L | 12.67 | 12.67 |
| | | | | **Unfactored reactions (kN)** | | **Total:** | **22.07** | **22.07** |
| | | | | | | *Dead:* | *9.41* | *9.41* |
| | | | | | | *Live:* | *12.67* | *12.67* |
| | | | | | | **Factored reactions:** | **33.44** | **33.44** |

**Total load: 44.15/66.87 kN** *Unfactored/Factored*

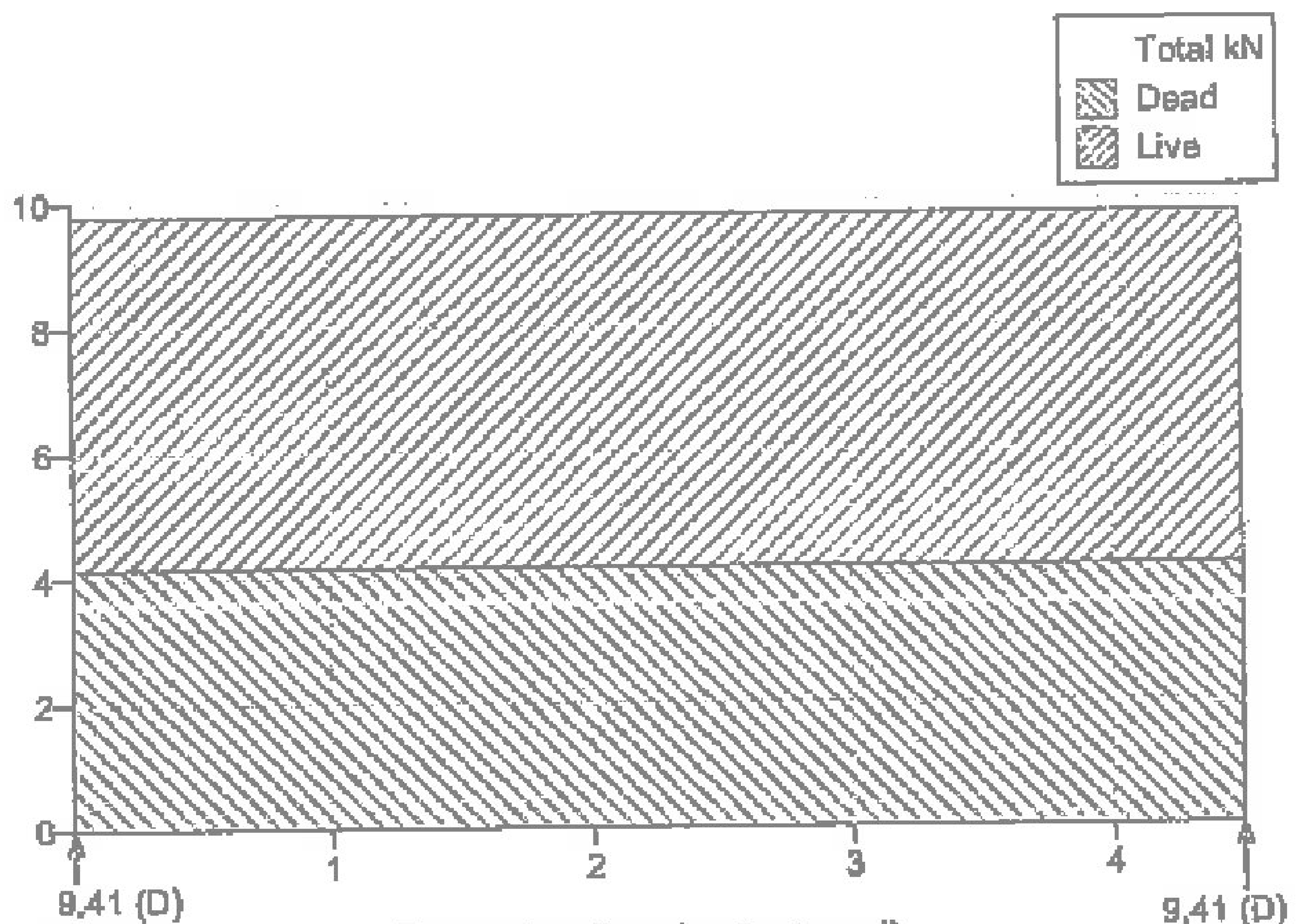
*Load types: U: UDL D: Dead; L: Live (positions in m. from R1)*

Maximum B.M. (factored) = 37.61 kNm at 2.25 m. from R1

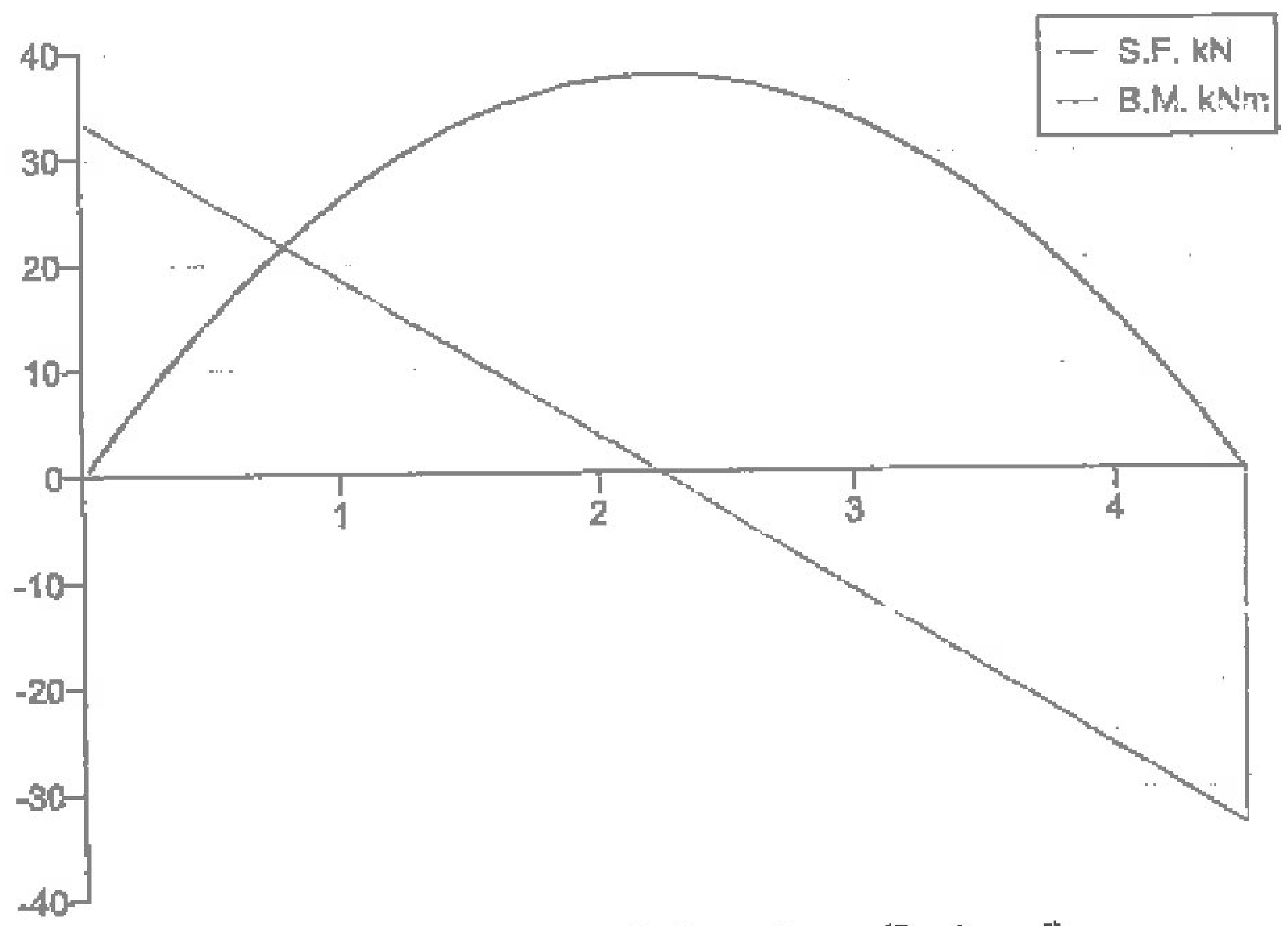
Maximum S.F. (factored) = 33.43 kN at 0.00 m. from R1

Live load deflection = 30.1 x $10^8$/EI at 2.25 m. from R1 *(E in N/mm², I in cm⁴)*

Total deflection = 52.4 x $10^8$/EI at 2.25 m. from R1



**Beam loading (unfactored)**



**Bending moment and shear force (factored)**

*Beam calculation to BS5950-1:2000 using S275 steel*

**SECTION SIZE : 203 x 133 x 30 UB** S275 (compact)

D=206.8 mm B=133.9 mm t=6.4 mm T=9.6 mm $I_x$=2,900 cm⁴ $r_y$=3.17 cm $S_x$=314 cm³ x=21.5

## Shear

Shear capacity = 0.6 $p_y$.t.D = 0.6 x 275 x 6.4 x 206.8/1000 = 218 kN (>=33.4) OK

## Bending

Maximum moment = 37.61 kNm at 2.25 m. from R1

Moment capacity, $M_c$ = $p_y$.$S_x$ = 275 x 314/1000 = 86.35 kNm OK

## Lateral-torsional buckling

Beam is laterally restrained at supports only
Restraint condition at R1 and R2: Compression flange laterally restrained. Nominal torsional restraint. Both flanges free to rotate on plan (1.0L) [BS5950 Table 13]
Effective length = 1.0L

Bending strength, $p_b$ = 136.4 N/mm²

Maximum moment within segment, $M_x$ = 37.61 kNm

Equivalent uniform moment factor, $m_{LT}$ = 0.925 ($M_2$=28.2, $M_3$=37.6, $M_4$=28.2)

Equivalent uniform moment = 0.925 x 37.61 = 34.79 kNm

Buckling resistance moment, $M_b$ = $p_b$.$S_x$ = 136.4 x 314/1000 = 42.83 kNm OK

## Web capacity

Check unstiffened web capacity with load of 33.44 kN

C1 = 60.5 kN; C2 = 1.76 kN/mm; C4 = 261; K = min{0.5+($a_e$/1.4d),1.0}; $p_{ww}$ = 275N/mm$^2$

*(for derivation of C factors see Steelwork Design Guide to BS5950-1:2000 6th ed.)*

Minimum required stiff bearing length, $b_1$ = 0mm: $a_e$ = 0mm; K = 0.500

Bearing capacity, $P_w$ = C1 + $b_1$.C2 = 60.5 kN <<<

Buckling capacity, $P_x$ = K√(C4.$P_w$) = 0.500√(261 x 60.5) = 62.9 kN

## Deflection

LL deflection = 30.06 x 1e8/205,000 x 2,900 = 5.1 mm (L/890) OK

TL deflection = 52.37 x 1e8/205,000 x 2,900 = 8.8 mm (L/511)