Beam Calculation Ltd Structural Calculations for Building Control Approval

Beam: Flitch Beam Span: 5.31 m. Load name Loading w1 Start x1 Loading w2 End x2 R1comp R2comp U D o.w. 0.4 0 L 1.06 1.06 U L Snow 0.75*(4.4/2) 0 L 4.38 4.38 U D Flat Roof 0.75*(1.44/2) 0 L 1.43 1.43 U D Pitched Roof 1.0*(3.0/2) 0 L 3.98 3.98 Total load: 21.72 kN 10.86 10.86 Dead: 6.48 6.48 Live: 4.38 4.38 Load types: U: UDL D: Dead; L: Live (positions in m. from R1) Maximum B.M. = 14.42 kNm at 2.66 m. from R1 Maximum S.F. = 10.86 kN at 0.00 m. from R1 Live load deflection = 17.1 x 108/EI at 2.65 m. from R1 (E in N/mm2, I in cm4) Total deflection = 42.3 x 108/EI at 2.65 m. from R1

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber Use 2no 50 x 220 C24 + 20 x 195 flitch plate 39.9 kg/m approx z = 806.7 cm3 I = 8,873 cm4 Flitch plate z = 126.8 cm3 I = 1236 cm4 Timber grade: C24 2 members acting together: K8 = 1.1 [§2.9] K3 (loading duration factor) = 1.00 (long term)

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Page 2 Client copy .SBW Printed 11 Oct 2017 12:31 K7 (depth factor) = (300/220)^0.11 = 1.03 [§2.10.6] K8 (load sharing factor) = 1.1 [§2.9,2.10] Loading will be carried by the timber members and flitch plate in proportion to their EI values. Checks are made using the mean and minimum E-values for timber to produce worst case stresses on timber and steel members respectively. See TRADA guidance document GD9, 2008, for more information. EIsteel = 205,000 x 1,236 x 104 = 2,533 x 109 Nmm2 Calculate K8A (modified K8 as per TRADA GD9) Using Emean, EItimber = 10,800 x 8,873 x 104 = 958 x 109 Nmm2 Timber carries 958/(958+2533) = 0.274 of total load (in worst case) K8A = 1.04 (EIsteel >= 0.2EItotal and EIsteel <= 0.8EItotal) Calculate effect of bolt holes M16 bolts, centres offset 0 mm from beam centre line: assume 17 mm holes To allow for holes factor bending stresses by 1.0 (timber) and 1.0 (steel) Bending Permissible bending stress, sm,adm = sm,g.K3.K7.K8A = 7.5 x 1.00 x 1.03 x 1.04 = 8.07 N/mm2 Applied bending stress, sm,a = 0.274 x 14.4 x 1.000 x 1000/806.7 = 4.90 N/mm2 OK Shear Permissible shear stress, tadm = 0.71 x 1.04 = 0.74 N/mm2 Applied shear stress, ta = 0.274 x 10.859 x 1000 x 3/(2 x 100 x 220) = 0.20 N/mm2 OK Deflection Using Emin x K9 (2 members) Timber EI = 7,200 x 1.14 x 8,873 x 104 = 728 x 109 Nmm2 Timber carries 728/(728+2,533) = 0.223 of total load (average case) Bending deflection = 0.223 x 42.3 x 108/(8,207 x 8,873) = 12.98 mm Mid-span shear deflection = 0.223 x 1.2 x 14.4 x 106/(E/16) x 100 x 220 = 0.34 mm Total deflection = 12.98 + 0.34 = 13.32 mm (0.0025 L) OK Mid-span creep deflection Note that this calculation simplifies the Annex K calculation by taking all live loads as the leading live load rather than just the primary one if more than one Service class 1 (dry) assumed: kdef = 0.6 y2 = 0.3 (domestic) Defldead = 25.26 Defllive = 17.08 Efin = Einst x (Defldead + Defllive)/(Defldead (1+ kdef) + Defllive (1 + y2.kdef)) = Einst x 0.699 Emin,fin = 7,200 x 1.14 x 0.699 = 5,738 N/mm2 Timber Emin,fin I = 5,738 x 8,873 x 104 = 509 x 109 Nmm2 Long term/instantaneous deflection = (728 + 2,533) / (509 + 2,533) = 1.07 Final deflection = 13.32 x 1.07 = 14.3 mm (0.0027 L) OK Check flitch plate Using Emin,fin for timber, flitch plate carries 2,533/(509 + 2,533) = 0.833 of total load Per TRADA GD9 factor load by 1.10 to allow for slip and shear deflection in plate Flitch plate fbc = 0.833 x 14.42 x 1.10 x 1.000 x 1000/126.8 = 104.2 N/mm2 OK Bolting Use M16 4.6 bolts. Bolt numbers are calculated assuming worst case load on flitch plate Load capacity per bolt in double shear = 7.70kN (BS5268 eq. G.9 - limiting value) (G.7: 8.33kN; G.8: 80.0kN; G.9: 7.70kN; G.10: 10.8kN) Fd=1350; My,d=196,608Nmm; pk=350kg/m3; K90=1.59; fh,0,d=11.17; fh,1,d=7.026; B and Ka taken as 1.0

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Bearings: R1 (10.9kN): Required number of bolts = 0.799 x 10.9/7.70 = 1.13 i.e. 2 bolts min. R2 (10.9kN): Required number of bolts = 0.799 x 10.9/7.70 = 1.13 i.e. 2 bolts min. For load transference a minimum of 3 bolts are also required across the span Recommended bolting pattern across span: Bolts at max 550 mm max c/s, alternately set 0mm above and below centre line of beam with an additional centred bolt at each significant point load position.