



Code of Practice BS 5268 Part 2: 2002 and BS 5628 Part 1: 2005 are provided

- Q1. Figure Q1 shows a wall cladding used to construct an outer wall in a warehouse. This warehouse has plywood cladding screwed to timber studs. The warehouse is constructed at very dry windy environment with average wind suction of 1.75 kN/m^2 . 12 mm thick plywood sheets are attached using 4 mm diameter and 38 mm long countersunk headed screws. The strength class of the timber material is C14.

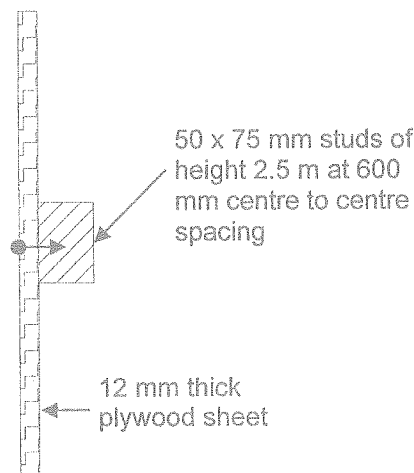


Figure Q1

- a) i) Determine number of screws required to resist the wind force. [4.0 Marks]
- ii) Determine the maximum spacing of screws [4.0 Marks]
- iii) Designer has to decide the suitability of using 3.4 mm diameter smooth round wire nails instead of 4 mm diameter countersunk headed screws. Clearly justify suitability of this replacement. [4.0 Marks]
- b) Discuss three different structural forms of timber pitch roof trusses. [3.0 Mark]

Q2. Figure Q2.1 shows an elevation of a proposed formwork arrangement to support a 125 mm thick reinforced concrete slab. Timber plywood boards are supported on timber joists, which are supported on a lattice girder made of timber and steel sections as shown in the Figure Q2.1. The lattice girder is supported on vertical timber props. It is intended to use timber belonging to Kempas (strength class D60 of BS 5268: Part 2) for all the timber elements of the formwork system.

The density of the timber is assumed as 1275 kg/m³ under wet conditions. The density of the concrete is 24 kN/m³ and the construction load during concreting is 1.25 kN/m². Preliminary calculations have shown that that timber boards of 12 mm thickness supported by timber joists spaced at 0.45 m centre to centre distance apart are adequate to support the reinforced concrete slab.

- a) (i) Explain three reasons for using timber in the formwork construction instead of steel systems. [2 Marks]
- (ii) Explain briefly why formwork timber should be seasoned prior to use in the construction sites. [2 Marks]
- (iii) What are the methods of timber preservative treatments available locally? [2 Marks]
- b) Determine the maximum span that a timber joist of 50 mm x 100 mm (dimensions of timber are in the dry exposure conditions) could span if it is simply supported at the ends for the following design criteria.

If the permissible bending stress of the timber should not be exceeded

If the permissible shear stress of the timber should not be exceeded

If the maximum permissible deflection is 3.0 mm

[8 Marks]

- c) The lattice girder consists of top and bottom chords of timber, vertical web members of timber and diagonal web members of steel. The lattice girder consists of eight equal panels. The overall depth of girder is 600 mm and it spans a distance of 4.0 m. The timber joists are located exactly at the node points of the girder. The design forces were obtained using a computer program. Table Q2 summarized analysis results necessary for design calculations. The node points of the truss have been analysed assuming pinned joints.
- i) Bottom and top chords are fabricated as twin members. Explain briefly reasons for selection of twin members instead of single member. [1 Mark]
- ii) Lattice girder consists of vertical and diagonal web members. If the lattice girder is designed only with vertical web members, do you recommend this system for the formwork? Justify your answer. [1 Mark]
- iii) Will the forces listed in Table Q2 be significantly different if the 10 mm diameter diagonal steel rods are replaced by 50 mm x 50 mm timber sections? Explain briefly benefits of such a replacement. [1 Mark]

- iv) Assuming that the load is transferred exactly at each node, explain how you would determine the maximum forces in the bottom chord of the lattice girder by using an approximate method. State (if any) assumptions you may need. Calculations are not required. [2 Marks]
- d) Vertical web members are connected to the top and bottom chords of the lattice girder by means of single 16 mm (M16) diameter central bolt. Figure Q2.2 shows the connection detail. It is made by inserting a 12 mm thick steel plate. You may assume that adequate end and edge distances are provided.
- i) Determine the load carrying capacity of a typical web member
- In compression
 - In tension
 - Considering the bolted connection capacity
- [6 Marks]
- ii) As a design engineer, do you recommend above connection detail for the formwork system? Give reasons for your answer. [1 Mark]
- e) Would you permit the girder to be placed in an inverted position? You may assume that the maximum force a diagonal steel member can carry is 20 kN in tension and 4.0 kN in compression. Give reason for your answer. [1 Mark]
- f) The lattice girder is supported on two columns as shown in Figure Q2.1. Effective height of a column is 2.5 m and both ends of the column are restrained in position and in direction. Strength class of the timber material used for column is equivalent to D70.
- i) Suppose load due to lattice girder including self weight of joist, plywood boards and concrete are transferred as a uniformly distributed load of 1.25 kN/m. Determine the axial load transferred to the column. [2 Marks]
- ii) Determine the critical slenderness direction. [2 Marks]
- iii) If the section failed by slenderness limits, suggest a suitable supporting method to enhance buckling capacity. As a design engineer how do you ensure that propose supporting method enhance buckling capacity? Explain briefly without doing any calculations. [2 Marks]
- iii) Check the adequacy of the column. Clearly indicate any assumptions you made in the calculations. [2 Marks]

Q3. The load bearing wall (wall AA) shown in Figure Q3.1 is built of 50 N/mm² bricks set in grade (iii) mortar. The bottom of AA wall is fixed at ground level while top is supported by a reinforced concrete slab. The category of manufacturing is to be category II and that for construction is special. The characteristic loads which are acting on wall AA are shown below.

- Characteristic vertical load on wall AA due to the dead load of concrete slab, upper wall and roof = 80 kN/m
- Characteristic vertical load on wall AA due to the imposed load of concrete slab, upper wall and roof = 20 kN/m

- a) Determine the design vertical load on wall AA. [2 Marks]
- b) Explain, with examples, what is the effect of lateral support on the effective height of the wall. [1 Mark]
- c) Calculate the effective height (h_e), effective thickness (t_e) and slenderness ratio of the wall AA. [3 Marks]
- d) Determine the load bearing capacity of the wall AA, and check the wall AA for failure due to direct compression. [3 Marks]
- e) Suppose if the wall AA built of concrete block instead of brick, suggest design method for wall AA? Explain briefly without doing any calculations. [1 Marks]

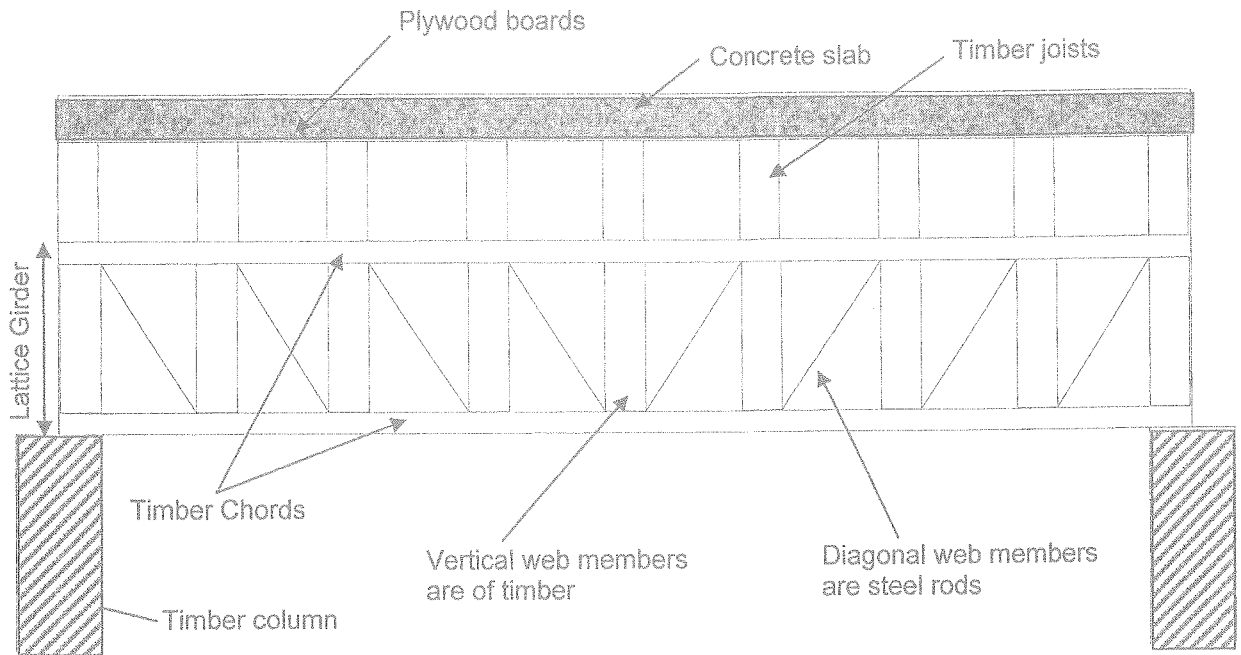


Figure Q2.1

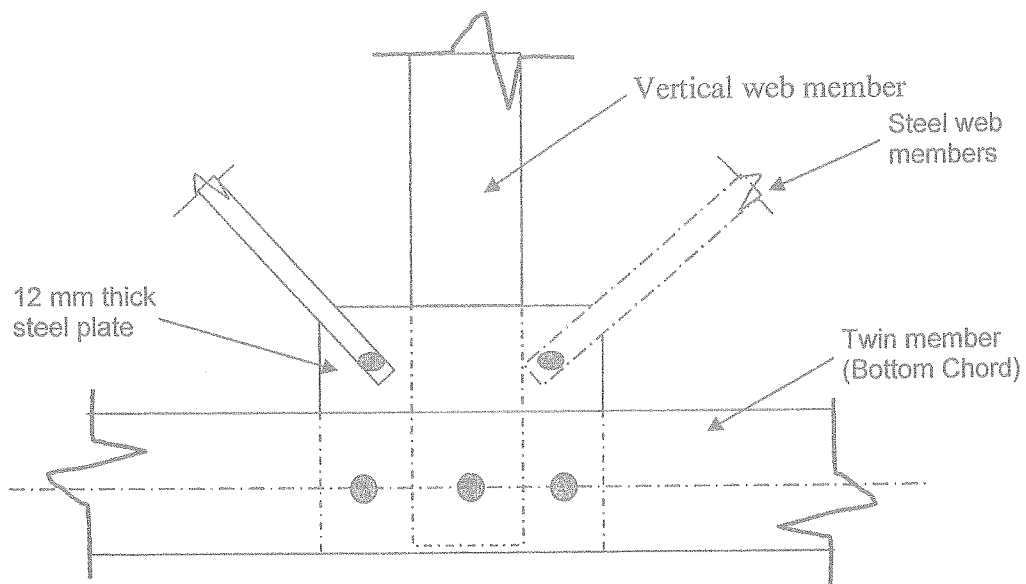


Figure Q2.2 Web member connection details

Table Q2 Member Details and Forces in the Lattice Girder

	Member	Timber section	Maximum force (kN) obtained from analysis
1	Bottom Chord	Twin members of timber, each of 50 mm * 50 mm	24.0 Tension
2	Top Chord	Twin members of timber, each of 50 mm * 50 mm	25.0 Compression
3	Vertical web	Single member of timber, each of 50 mm * 50 mm	13.5 Compression
4	Diagonal web	Single steel rod of 10 mm diameter	19.0 Tension

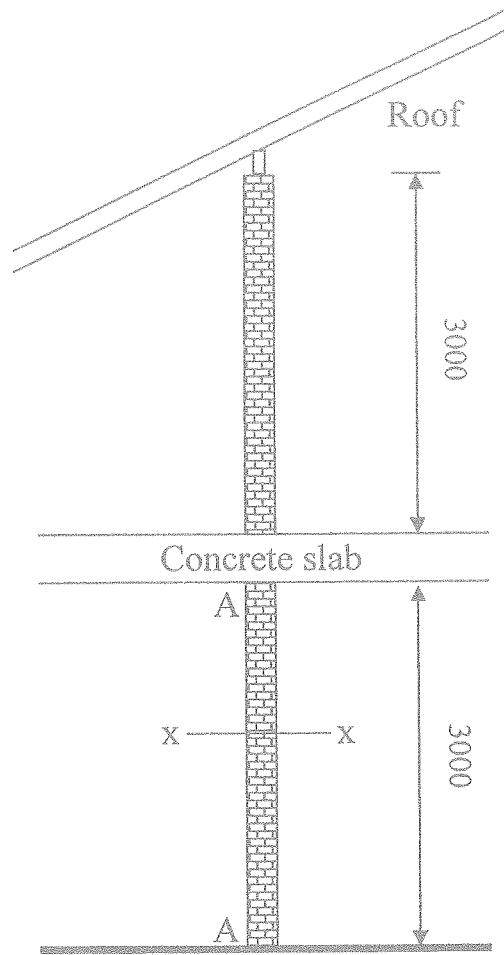


Figure Q3.1

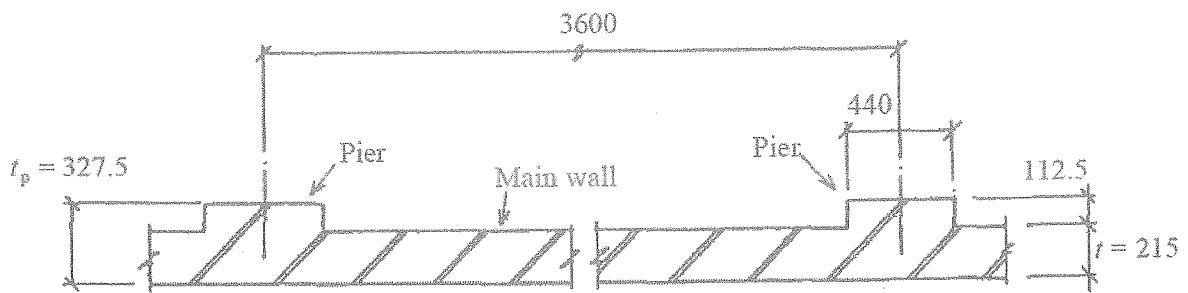


Figure Q3.2: Section x-x

(All dimensions are in 'mm')