STRUCTURAL DESIGN CALCULATION REPORT

STRUCTURAL MODIFICATION AND MEZZANINE ADDITION

CLIENT:

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GENERAL NOTES:

These calculations are based upon the drawings supplied. Any alterations to these drawings or changes effect on site during construction, could materially effect sizes of structural members that have been designed and adopted on plan. The latter should be brought to the notice of the structural Engineer with specific instructions to prepare revised calculations to accommodate the changes made.

No inspection of the existing soil conditions has been made by the designer, and no information appertaining to the latter have been offered. No work appertaining to the plans should be carried out until the plan and calculations have been examined by the local authority, and formal written approval obtained. Any works carried out before such approval is obtained, is done solely at contractors or owners risk.

The availability of new and or existing foundation to sustain the new loading arrangement should be verified on site and agreement reached with the Building Control Officer and appropriate changes made where applicable. The condition of all existing load bearing walls to be verified on site and agreement reached with Building Control Officer as to their suitability.

Design Standards:

Design has been carried out according to following standards:

- Loading BS 6399
- Steel 5950

GENERAL CONSTRUCTION NOTES:

- Provide 25mm dry pack between new steels and underside of existing masonry.
- Provide movement joints in unbroken lengths of blockwork @ 6m cts, 3m from corners unless minor cracking from shrinkage is acceptable.
- Steels supporting floors encased for half hour fire resistance (2-layer plaster board or intumescent paint).
- All works to be carried out in accordance with the CDM regulations with the appointment of a CDM coordinator and preparation of pre-tender health & safety plans with risk assessments etc.
- Temporary needle propping to be inspected by Engineer prior to removal of masonry forming new opening. Minimum requirements @ 1.0m cts set 500mm from each side of wall onto solid base.
- All new steels to be supplied with two coats zinc phosphate. Coat with two layers bituminous paint where in contact with external walls or below damp-proof course. Also encase in 100mm concrete where below ground level. Any steel exposed to the elements such as plate supporting external skin should be stainless steel or hot dip galvanized. Pad stones to be in situ/precast concrete or engineering brick as specified (do not use cut down pre-stressed concrete lintels). Min 100mm bearings. Take overall beam length from site dims.

GENERAL LOADING:

Dead Loads:

Timber stud wall	=	0.3 KN/m Line load
	=	0.25 KN/m2 Blanket load
100 mm block wall	=	1.75 KN/m Line load
		0.75 KN/m2 Blanket load
Load Bearing block wall =		5 KN/m Line load

Floor

Timber floor	=	1 KN/m2
Sand/Screed floor	=	2.5 KN/m2
Others	=	0.5 KN/m2

Finishes

Concrete tiles	=	1 KN/m2

Live Loads:

Domestic floor	=	1.5 KN/m2
Attic floor	=	1 KN/m2
For flat roof	=	1 KN/m2
Pitched roof	=	1 KN/m2

Wind Loads:

For roof	=	0.90 KN/m2

This design is in accordance with BS 5268-2:2002 Structural use of timber - Part 2: Code of practice for permissible stress design, materials and workmanship. The depth to width ratio of the timber does not exceed 5 and as per the requirements of BS 5268-2 Table 19 there is no risk of buckling under design load provided.

Mezzanine Floor Timber Beams DESIGN:

Critical beam has been designed for Mezzanine addition.

Grade = C24

Maximum Span of the beam = L = 3.5 m

B = 100 mm

H = 250 mm

Permanent (Dead) Actions:

Floor dead loads = 1 KN/m2

Let's take 0.25 KN/m2 as self-weight of beam

Total dead loads = Gk = 1.25 KN/m2

Variable (Live) Actions:

Total live loads = Qk = 1.5 KN/m2

Let us work out on the design actions and draw the shear force and bending moment diagrams assuming the beam as simply supported.

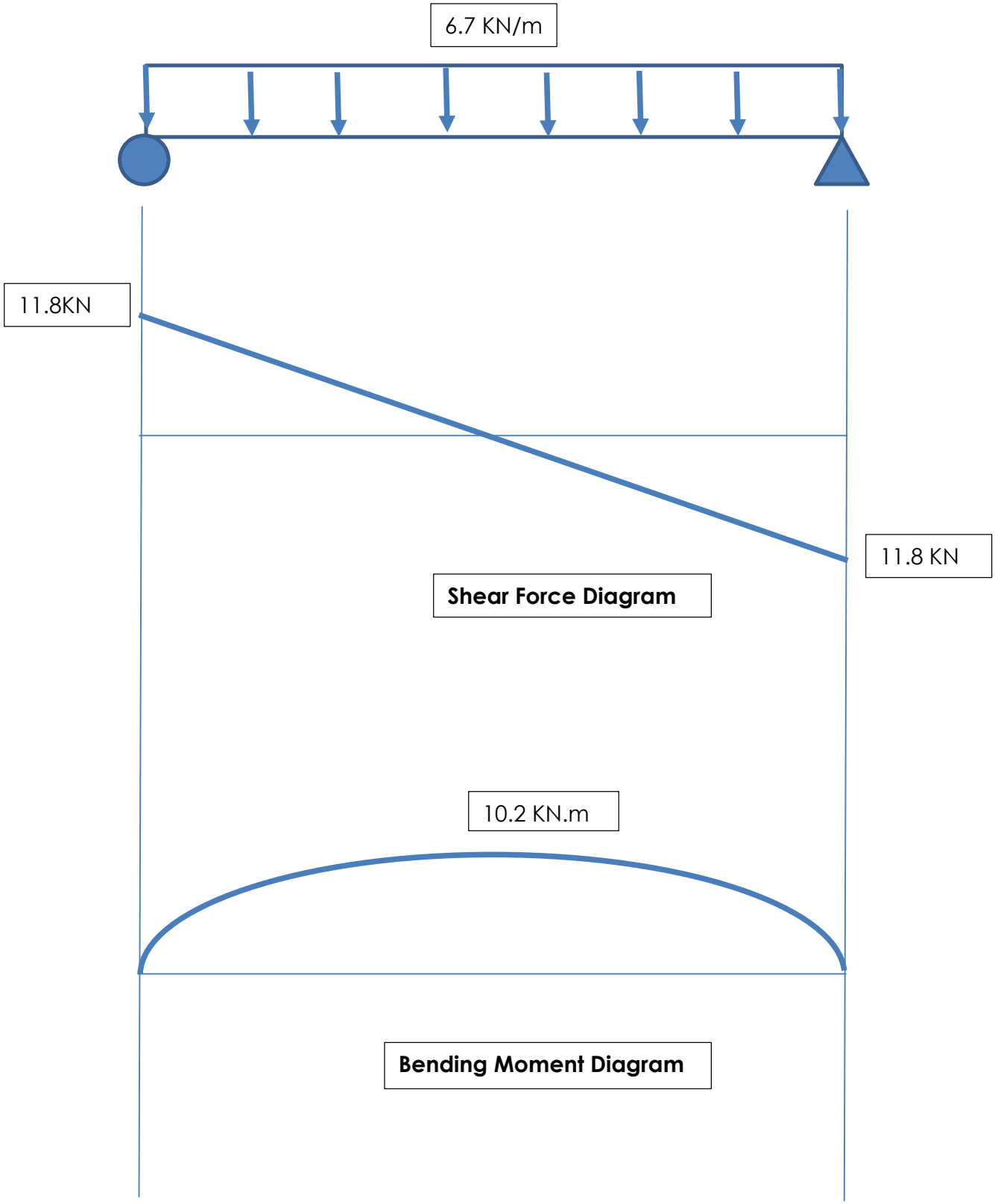
Total design load = 1.35 Gk + 1.5 Qk

= 1.35 x 1.25 + 1.5 x 1.5 = 3.93 KN/m2

Effective width supported by the beam = 3.4/2=1.7m

Factored U D L acting on the beam = w = 3.93x1.7 =6.7KN/m

Shear force and bending moment diagrams are shown below:


6.7 KN/m
11.8KN
11.8 KN
Shear Force Diagram
10.2 KN.m
Bending Moment Diagram

Section design parameters

From the shear force diagram we have,

Design shear force = V Ed = 11.8 KN

Design bending moment = M Ed = 10.2 KN.m

Timber minimum modulus of elasticity Emin = 7,200 N/mm²

Modification factors

Timber service class modification factor K2 as table 16

Bending parallel to grain K2,ben = 1.00

Compression perpendicular to grain K2,per = 1.00

Shear parallel to grain K2,shr = 1.00

Mean & min modulus of elasticity K2,mod = 1.00

Load duration factor K3 = 1.25

Bearing modification factor K4 = 1.00

Depth factor (BS5268-2 clause 2.10.6) K7 = (300 / h)0.11 = 1.03

Load sharing modification factor (BS5268-2 clause 2.10.11) K8 = 1.10

Modulus of elasticity modification factor (BS5268-2 clause 2.9) K9 = 1.21

Section properties

Area of section Area = b × h = 25000 mm²

Inertia of timber about xx axis I xx = b × h³ / 12 = 130,208,333 mm 4

Z to top edge of timber Z = b × h² / 6 = 1,041,666 mm³

Average density for C24 grade timber (BS 5268-2:2002 Table 8)

ρmean = 420 kg/m³

Bending Stress Check:

Timber grade bending stress parallel to grain (BS5268-2 Table 8) σt,m,g,par = 7.5 N/mm²

Permissible timber bending stress (factored) σt,m,adm = σt,m,g,par × K2,ben × K3 × K7 × K8
= 10.7 N/mm²
Maximum bending moment M = 10.2 kNm
Applied bending stress in timber σt,m,max = M / Z = 10.2x10^6/1041666 N/mm² = 9.79 N/mm²

Pass

σt,m,max <= σt,m,adm (9.79 N/mm² <= 10.67 N/mm²)

Applied Bending Stress in Timber Within Permissible

Check shear stress

No notches to occur at the critical shear position.
Timber grade shear stress parallel to grain (BS5268-2 Table 8) τt,g,par = 0.71 N/mm²
Permissible shear parallel to grain (factored) τt,adm = τt,g,par × K2,shr × K3 × K8 = 0.976 N/mm²
Permissible shear force on timber Ft,adm = 2 × τt,adm × b × h / 3 = 2x0.976x100x250/3= 16.2 KN
Design shear force Fve = 11.8 KN

Pass

Fve <= Ft,adm 11.8 KN <= 16.2 KN)

Shear Capacity of Timber Is Greater Than Applied Shear Force, Therefore OK

Deflection Check:

Actual deflection at serviceability state is calculated as:

Actual deflection = 5/384 x w l x L^4/ Elz

So,

Actual deflection = 5/384 x1x 3500^4/ 7,200 x 130,208,333

= 8.4 mm

Allowable deflections = L/270 = 3500/ 270 = 12.9 mm

Pass

δmax <= δadm (8.4 mm <= 12.9 mm),

Therefore, OK For Deflection

Mezzanine Floor Joist Design:

Mezzanine floor joists have been designed for maximum span and following design loads

Span of the beam = L = 3.4 m (max)

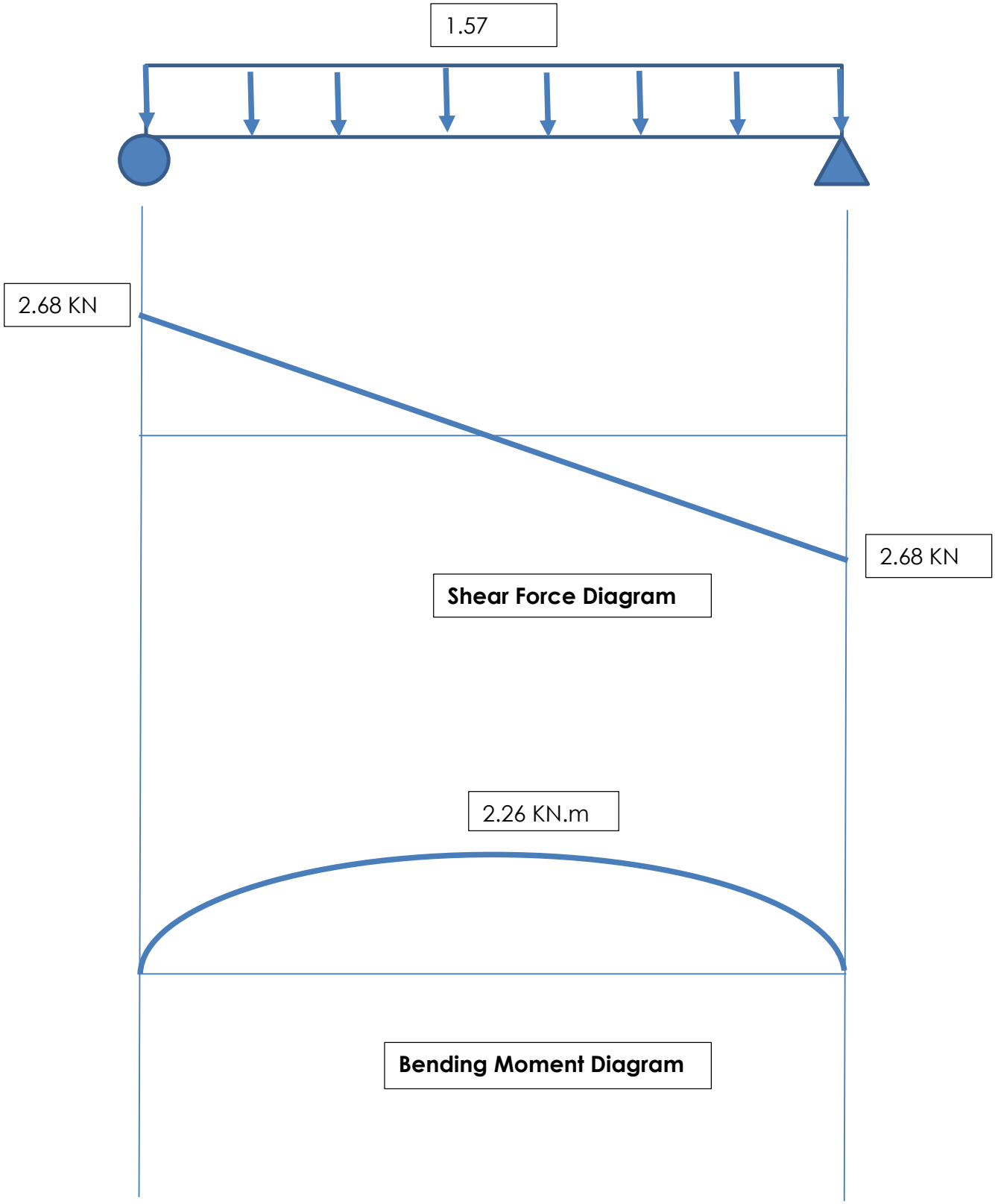
Permanent (Dead) Actions:

Floor dead loads = 1 KN/m2
Let's take 0.25 KN/m2 as self-weight of beam

Total dead loads = Gk = 1.25 KN/m2

Variable (Live) Actions:

Total live loads = Qk = 1.5 KN/m2
Let us work out on the design actions and draw the shear force and bending moment diagrams assuming the beam as simply supported.
Total design load = 1.35 Gk + 1.5 Qk
= 1.35 x 1.25 + 1.5 x 1.5 = 3.93 KN/m2
Spacing of joists = 400 mm C/C
Factored U D L acting on the beam = w = 5.7x0.4 = 1.57 KN/m per linear meter
Shear force and bending moment diagrams are shown below:


1.57
2.68 KN
2.68 KN
Shear Force Diagram
2.26 KN.m
Bending Moment Diagram

Section design parameters

From the shear force diagram we have,

Design shear force = V Ed = 2.68 KN

Design bending moment = M Ed = 2.26 KN.m

Section properties

Timber minimum modulus of elasticity Emin = 7,200 N/mm²

B = 50 mm

H = 250 mm

Area of section Area = b × h = 12500 mm²

Inertia of timber about xx axis I xx = b × h³ / 12 = 65104166 mm 4

Z to top edge of timber Z = b × h² / 6 = 520833 mm³

Average density for C24 grade timber (BS 5268-2:2002 Table 8)

ρmean = 420 kg/m³

Bending Stress Check:

Timber grade bending stress parallel to grain (BS5268-2 Table 8) σt,m,g,par = 7.5 N/mm²

Permissible timber bending stress (factored) σt,m,adm = σt,m,g,par × K2,ben × K3 × K7 × K8 = 10.7 N/mm²

Maximum bending moment M = 2.26 kNm

Applied bending stress in timber σt,m,max = M / Z = 2.26x10^6/520833 N/mm² = 4.34 N/mm²

Pass

σt,m,max <= σt,m,adm (4.34 N/mm² <= 10.67 N/mm²)

Applied Bending Stress in Timber Within Permissible

Check shear stress

No notches to occur at the critical shear position.

Timber grade shear stress parallel to grain (BS5268-2 Table 8) $\tau t,g,par = 0.71$ N/mm²

Permissible shear parallel to grain (factored) $\tau t,adm = \tau t,g,par \times K2,shr \times K3 \times K8 = 0.976$ N/mm²

Permissible shear force on timber $Ft,adm = 2 \times \tau t,adm \times b \times h / 3 = 2x0.976x50x250/3 = 8.1$ KN

Design shear force Fve = 2.68 KN

Pass

Fve <= Ft,adm 2.68 KN <= 8.1 KN)

Shear Capacity of Timber Is Greater Than Applied Shear Force, Therefore OK

Deflection Check at Serviceability:

Actual deflection at serviceability state is calculated as:

Actual deflection = 5/384 x w l x L^4/ Elz

So,

Actual deflection = 5/384 x1x 3400^4/ 7,200 x 65104166= 6.4 mm

Allowable deflections = L/270 = 3400/ 270 = 12.6 mm

As,

Actual deflection = 6.4 mm < Allowable deflections = L/270 = 12.6 mm

Hence deflection check is satisfied

Pass

δmax <= δadm (6.4 mm <= 12.6 mm),

Therefore, OK For Deflection

Hence Provide 50 x 250 @ 400 Crs C16

Notes Joists to be bolted together with M12 bolts at 600mm spacing or equivalent.