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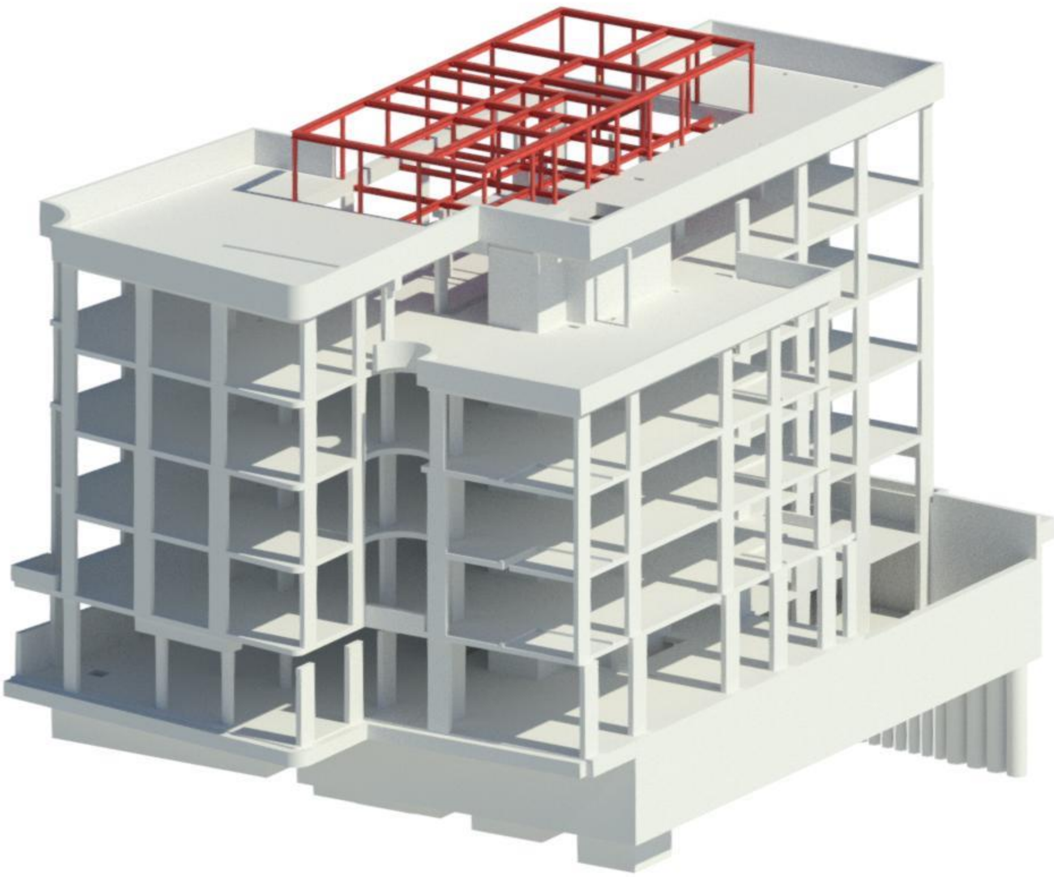
structural and civil engineers

SuDS Feasibility Study

18-22 Haverstock Hill



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Contents:

Appendices

1. Executive Summary

The following SuDS feasibility study report has been prepared by Engineeria for the development at 18-22 Haverstock Hill Project in response to the document received from the Lead Local Flood Authority – London Borough of Camden (Planning reference: 2019/5440/P) requesting for a feasibility study into the possibility of incorporating a blue roof system into the development.

The following reports have been issued previously to Camden Council:

- SuDS report (No: E0648-EEE-00-XX-RP-C-0010 Rev P1) on 21.08.2019 addressing Condition 8 for the planning permission for the proposed development (reference: 2018/2179/P).
- SuDS Technical addendum report (No: E0648-EEE-00-XX-RP-C-0010 Rev P2) in response to the request for further information from the Lead Local Flood Authority – London Borough of Camden. Planning reference: 2019/5440/P. The addendum report provides calculation and the attenuation volume size justifying the reduced surface water flow discharge rate of 2.4 l/s (2 - 2.5 l/s as requested).

The conclusions of the feasibility study are that the incorporation of a blue roof system is <u>not feasible</u> due to the following primary reason:

- Increase in loading on the structure:
    - It is not feasible to include the total volume of attenuation at roof level due to the increase in loading on the raft slab (construction of which has already commenced following a detailed iterative raft slab analysis) and also superstructure.
    - In order to justify a raft solution (a more sustainable foundation solution than piling), building loads have been kept as low as possible. This is evident in the use of a steel and timber structural frame at 5th and roof floor level in lieu of concrete.

The SuDS solution provided (green roofs and below ground attenuation tank) represents the most suitable strategy based on due consideration of the SuDS hierarchy, given the site and building constraints.

Additional considerations and further commentary on Policies CC2 and CC3 from the Camden Local Plan are addressed in Sections 2 and 3.

2. Policy CC2 Adapting to climate change.

The Council will require development to be resilient to climate change.

All development should adopt appropriate climate change adaptation measures such as:

a. The protection of existing green spaces and promoting new appropriate green infrastructure

In the existing condition, 100% of the site area is covered in impermeable hard surface. The existing building site does not have any attenuation system, therefore runoff from the site is directly discharged into the public sewer.

The proposed new development includes allowance for green spaces in the form of green roofs which cover approximately 50% of the site area promoting green infrastructure appropriate to the site.

b. Not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems

As indicated in "item a" above and the SuDS report issued previously, the existing brownfield site is 100% impermeable. The proposed development will reduce the surface runoff discharge rate by gradually releasing storm water to the public sewer by provision of green roofs and attenuation system.

Due to the provision of the Sustainable Urban Drainage Systems in the proposed development, the surface water discharge rate to the public sewer by has been reduced by 72% for Storm return period of 1 year and 93% for return period of 100 years + 40% Climate Change during the high intensity rainfall event.

The green roof behaves as a permeable surface as the rainwater percolates through the soil layer and the substrate under, prior to releasing at a slow rate to the attenuation tank at ground floor level.

Green roofs and attenuation tank provided within the development are forms of Sustainable Urban Drainage Systems. Water from the attenuation tank is designed to discharge via **gravity** to the public sewer at a reduced rate of 2.4 l/s therefore is a sustainable system as pumps are not required to discharge water from the attenuation tank.

Reference have also been made to pages 8, 12, 28 and 29 in CIRIA C753 SUDS Manual.

c. Incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate

The proposed development allows for green roofs of various depths (up to 450/600mm deep) as indicated in the landscaping architect's drawing in Appendix 8 of SuDS Technical addendum report (No: E0648-EEE-00-XX-RP-C-0010 Rev P2). Green roofs are seeded with Bauder flora / planter with shrubs and small standard trees are allowed for at various roof levels incorporating bio-diversity in the proposed site. Green roofs are part of SuDS feature, as they are a natural way of attenuating the flow as opposed to direct discharge via drains and pipes. The green roof provided is a sustainable solution to intercept and retain precipitation, reducing the volume of runoff and attenuating peak flows.

"The Draft London Plan December 2017 – Policy SI13 Sustainable drainage – text 136" states that attenuation tanks are typically lower on the SuDS hierarchy given the requirement for pumping. However, the current attenuation solution does not require a pump given the levels of the tank and the public sewer.

The development proposes installation of solar panels and green roof at roof level - helping in the reduction of carbon emission by making use of the renewable energy generated.

- If a blue roof was used, a separate chamber would still be required at ground level to capture the surface water discharged from the lightwells located at rear in basement level.
- Provision of the 2 forms of attenuation system would require additional cost for installation and maintenance.

In addition, listed below are adverse structural impacts as a result of installation of a blue roof system at high level.

I. Minimum of 150mm layer of storage will be required if they were to be installed at roof level, fifth and fourth floor terraces.
II. Increased in load allowances for storage of the water will result in the current 200mm deep joists failing by 56.3% requiring the depth of the joists to be increased to 250mm. Refer to the structural calculation provided in "Appendix A".
III. Including the depth of the storage layer, the overall roof height will require to be raised by 200mm.
IV. Installation of the blue roof above the timber joists at roof level would pose risk to the integrity of the roof. The design life of the permanent roof structure (steel and timber joists) exceeds the design life of the blue roof even with rigorous maintenance. Damages to blue roof system may result in water damage to the roof structure whilst water is actively stored at the roof level.
V. As the allowance of active storage of water at roof level is not preferred, the required storage volume will require to be stored at fifth and fourth floor terraces. This will result in increase of the floor buildup by 300mm to allow for the storage units under the green roofs.
VI. Structural assessment has been carried out for the reinforced concrete slab at fifth floor level for the purpose of the feasibility report. Summary provided in the Appendix B.
VII. As indicated in the document attached to Appendix A, increase in loading on a suspended reinforced concrete slab will require increased reinforcement and slab thickness. Increase in volume of concrete and steel tonnage would be unsustainable and incur additional cost for material and procurement.
VIII. Including approximately minimum 25mm increase in thickness of slab and the 300mm from the storage layer the floor buildup will require to be raised by minimum of 325mm.
IX. Statements in VI, VII and VIII are true for the slab at fourth floor level.
X. Installation and maintenance requirement will require stringent specification with potential for failure of the system leading to water damage to the habitable spaces.
XI. Storage of water at higher level will have increased loading on the reinforced concrete columns provided. The value of which will vary in each column dependent on the arrangement and span of the slab being supported on it.
XII. Transfer beams at first floor and fourth floor will have increased loading and will require to be increased in dimension impacting on the ceiling buildup and clear floor to ceiling height. This is also dependent on the loadings from the columns supported.
XIII. The development is supported onto reinforced concrete raft foundation as opposed to piled foundation. As such, the increase in loadings by approximately 5-6% will have significant adverse impact on the settlement of the foundation and potential adverse impact on the adjoining building.

As stated in CIRIA C753 SuDS manual 2015, green roof is an example of SuDS system. Reference has been made to CIRIA SuDS Manual 2015, pages 8 (example of SuDS), Page 28 (Box 1.3 Function of SuDS component), page 29 (Table 1.1 Types of SuDS component) and Chapter 12.

The development has suitable space available for storage of rainwater within the site below ground level with an invert level enabling gravity discharge. Therefore, the proposed drainage strategy above meets all the requirement of Camden planning policy CC2.

Policy CC3 Water and flooding

The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible.

a. Incorporate water efficiency measures

- To reduce the consumption of potable water in the home, the dwellings would be provided with flow restrictors on taps, efficient washing machines and dishwashers (where provided), and dual-flush systems for the WC.
- Individual water meters would be provided for each new dwelling, for each tenant to manage, and be charged for, their individual consumption.

b. Avoid harm to the water environment and improve water quality

The proposed development will not harm the water environment.

- The proposed development to be installed with green roof in the area of approximately 337m^2. The proposed development has approximately 46% more green area (green roof) in comparison to hard landscaped existing site condition.
- The rainwater will pass through the green roofs before it discharges to the below ground drainage. Hence the new development improves the quality of surface water and will help to restrict transport of pollutant to the below ground drainage.

Hence, this meets the Camden Planning policy.

c. Consider the impact of development in areas at risk of flooding (including drainage)

The drainage is designed for the 1 in 100years plus 40% climate changes to accommodate surface runoff from the site of 0.074ha. The proposed development will not increase flood risk elsewhere but provide a betterment of existing risks of surface water flooding as it reduces the peak discharge rate from the site when compared to the existing condition.

Also please refer to the Basement Impact Assessment report submitted to Camden Council.

d. Incorporate flood resilient measures in areas prone to flooding

The proposed development is less than 1ha and is within Flood Zone 1. The site is not at risk of flooding from Rivers or the sea. Therefore flood resilient measures were not required.

Also please refer to the Basement Impact Assessment report submitted to Camden Council.

e. Utilises Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a Greenfield run-off rate where feasible

The drainage hierarchy comprises as follows:

- Store rainwater - Rainwater harvesting for this development has not been considered due to area constraints on site.

- Infiltration techniques - Infiltration techniques can be adopted only in areas situated a minimum of 20m away from the railway track (as per the railway regulation) and 5m away from the building foundation/ boundary (to comply the building regulation) to avoid the possibility of structural subsidence in the future. It is therefore not a viable solution to discharge the surface water from the site to the ground via infiltration technique due to it's proximity from Northern Line tube tunnel and the footprint of the development covering the site.

- Attenuate rainwater in ponds or open water features for gradual release - due to the size of the development, ponds and other open water feature is not possible for this site. Hence, this technique is not considered.

- Attenuate rainwater by storing in tanks or sealed water features for gradual release -

The proposed development aimed the discharges restricted to Greenfield runoff rate (GFRR). Using the MicroDrainage Source Control module Greenfield runoff rate calculator, Engineeria have calculated that the GFRR for the 0.074ha site catchment area is as follows:

- Qbar: 0.3l/s
- 1year: 0.2l/s
- 30yrs: 0.7l/s
- 100yrs: 0.9l/s

The greenfield runoff rates of this site has too low to effectively control with available flow control devices and to avoid the future blockage on the throttle pipe, Engineeria has proposed 2.4 l/s and it is within the range of discharge flow rates proposed by Camden Council (2 to 2.5l/s).

Table below summarised the peak discharge from existing and the proposed development as estimated using MicroDrainage.

Storm Return Period	Existing peak flow discharge (l/s)	Proposed discharge (l/s)	Reduction in percentage
1 year	8.8	2.4	72
30years	21.2	2.4	88
100 years	27.8	2.4	91
100yrs+40%CC	38.92	2.4	93

The above table shows the drainage proposal meets the Camden policy as a minimum 50% reduction in runoff rate across the development is required.

The green roof is acting as the permeable surface as the rainwater is percolating through the soil layer and the substrate and it release slowly to the attenuation tank in the ground floor. The proposed green roof accommodate approximately 1.68m^3/s flow volume.

In Engineeria's adherence to CIRIA SuDS Manual 2015, attenuation tank with gradual release of storm water from the tank is the SuDS system suitable to the site.

- Discharge rainwater direct to a watercourse - There are no watercourses within close proximity to the site therefore there is no opportunity to discharge surface water to an existing watercourse.
- Discharge rainwater to a surface water sewer/drain - No surface water sewer within the proximity to the site hence there is no opportunity to discharge surface water into the public or local authority surface water drainage system.

- Discharge rainwater to the combined sewer - Surface water from the existing site currently discharges into the public sewer (combined water sewer). Given the above alternative options are not viable, surface water from the proposed development will also need to be discharged to public combined sewer.

f. Not locate vulnerable development in flood-prone areas. Where an assessment of flood risk is required, development should consider surface water flooding in detail and groundwater flooding where applicable.

No flood Risk Assessment is required as the site is less than the 1ha and is located in the Flood Zone 1. The development is not prone to flood risk.

Proposed drainage meets the requirement of the NPPF, LBC Planning Practice Guidance including London Planning Policy 5.13.

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APPENDIX A

TIMBER JOIST ANALYSIS & DESIGN (EN1995-1-1:2004)

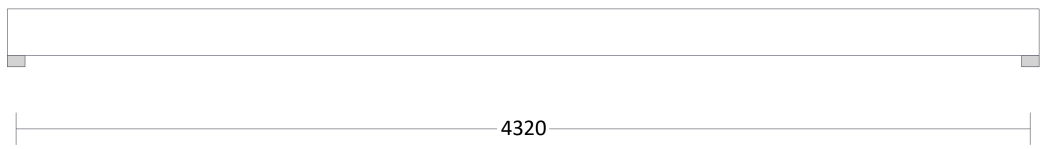
In accordance with EN1995-1-1:2004 + A2:2014 incorporating corrigendum June 2006 and the UK national annex

Tedds calculation version 2.2.00

Joist details

Description: 47 x 200 C24 timber joists

Joist spacing: s_{Joist} = **300** mm



Forces input on Joist

Vertical permanent load on joist: F_{G_Joist}= **1.80** kN/m^2

Vertical imposed load on joist: F_{Q_Joist}= **0.75** kN/m^2

Joist loading details

Distributed loads

Vertical permanent load on joist: $p_G = F_{G\_Joist} \times s_{Joist}$= **0.54** kN/m

Vertical imposed load on joist: $p_Q = F_{Q\_Joist} \times s_{Joist}$= **0.23** kN/m

ANALYSIS

Tedds calculation version 1.0.28

Loading

Self weight included (Permanent x 1)

Load combination factors

Load combination	Permanent	Imposed	Snow	Wind
1.35G + 1.50Q (Strength)	1.35	1.50	0.00	0.00
1.35G + 1.50Q + ψ_S1.50S (Strength)	1.35	1.50	0.75	0.00
1.35G + $\psi_0$1.50Q + 1.50S (Strength)	1.35	1.05	1.50	0.00
1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)	1.35	1.50	0.75	0.75
1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength)	1.35	1.05	1.50	0.75
1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength)	1.35	1.05	0.75	1.50
1.0G + 1.50W (Strength)	1.00	0.00	0.00	1.50
1.00G + 1.00Q (Service)	1.00	1.00	0.00	0.00
1.00G + 1.00Q + ψ_S1.00S (Service)	1.00	1.00	0.50	0.00
1.00G + 1.00Q + ψ_S1.00S + ψ_W1.00W (Service)	1.00	1.00	0.50	0.50
1.00G + $\psi_0$1.00Q + 1.00S + ψ_W1.00W (Service)	1.00	0.70	1.00	0.50
1.00G + $\psi_0$1.00Q + ψ_S1.00S + 1.00W (Service)	1.00	0.70	0.50	1.00
1.0G + 1.00W (Service)	1.00	0.00	0.00	1.00

Load combination	Permanent	Imposed	Snow	Wind
1.00G + $\psi_2$1.00Q (Quasi)	**1.00**	**0.30**	**0.00**	**0.00**

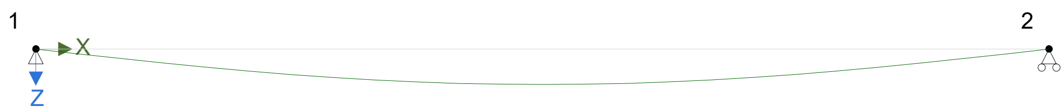
Member Loads

Member	Load case	Load Type	Orientation	Description
Member	Permanent	UDL	GlobalZ	0.54 kN/m at 0 m to 4.32 m
Member	Imposed	UDL	GlobalZ	0.23 kN/m at 0 m to 4.32 m

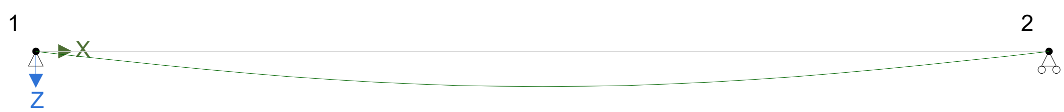
Results

Total deflection

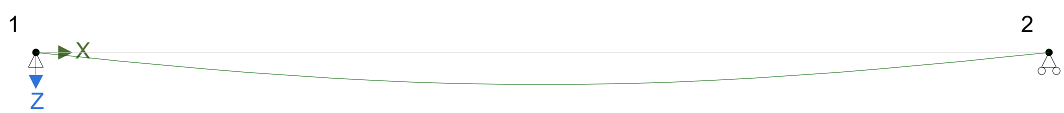
1.35G + 1.50Q (Strength) - Total deflection



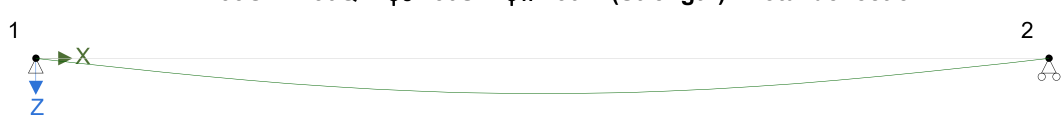
1.35G + 1.50Q + ψ_S1.50S (Strength) - Total deflection



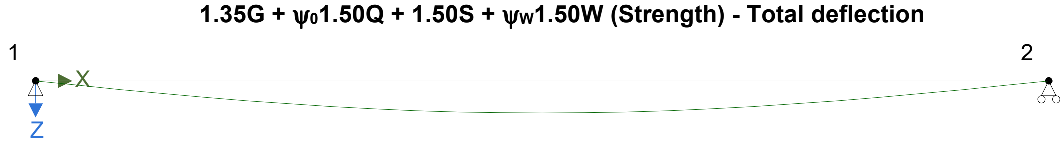
1.35G + $\psi_0$1.50Q + 1.50S (Strength) - Total deflection



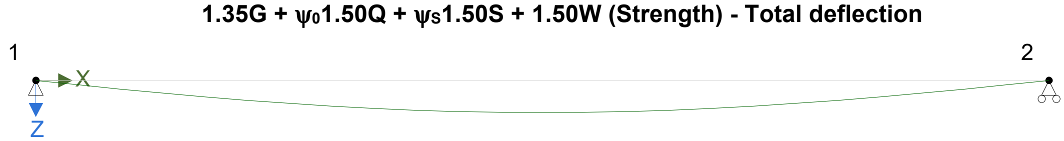
1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength) - Total deflection



1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength) - Total deflection



1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength) - Total deflection



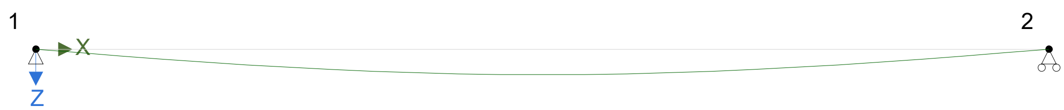
Tekla Tedds Engineeria	Project				Job Ref.	
	18-22 Haverstock Hill				E0648	
	Section				Sheet no./rev.	
	Roof Joists				E0648-CAL- 2402 -REV1	
	Calc. by	Date	Chk'd by	Date	App'd by	Date
	PG	13-Feb-20	PG	10-Feb-20	PG	10-Feb-20

1.0G + 1.50W (Strength) - Total deflection

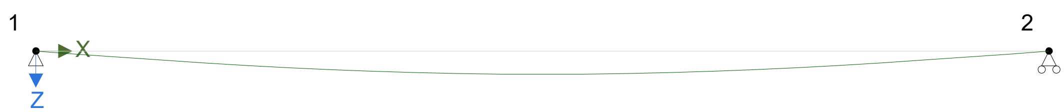
1.00G + 1.00Q (Service) - Total deflection

1.00G + 1.00Q + ψ_s1.00S (Service) - Total deflection

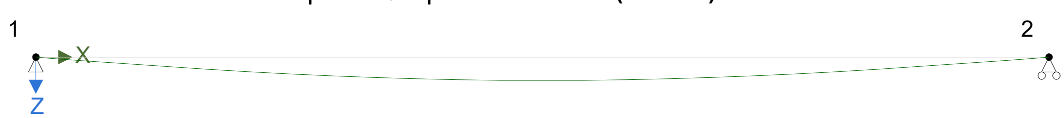
1.00G + 1.00Q + ψ_s1.00S + ψ_w1.00W (Service) - Total deflection



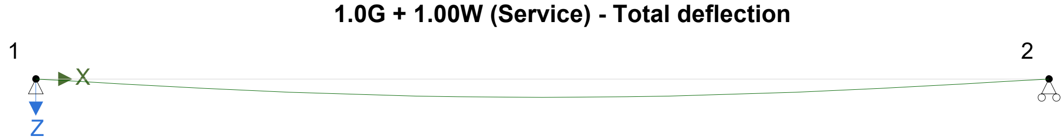
1.00G + $\psi_0$1.00Q + 1.00S + ψ_w1.00W (Service) - Total deflection



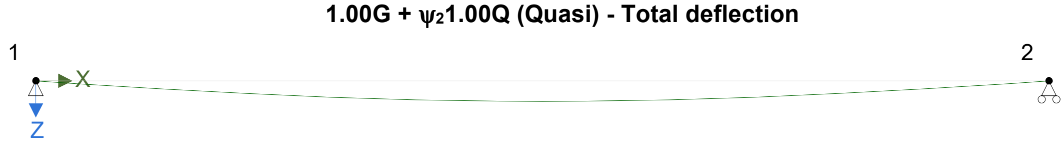
1.00G + $\psi_0$1.00Q + ψ_s1.00S + 1.00W (Service) - Total deflection



1.0G + 1.00W (Service) - Total deflection



1.00G + $\psi_2$1.00Q (Quasi) - Total deflection



Node deflections

Load combination: 1.35G + 1.50Q (Strength)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.61988	
2	0	0	-0.61988	

Load combination: 1.35G + 1.50Q + ψ_S1.50S (Strength)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.61988	
2	0	0	-0.61988	

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S (Strength)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.56334	
2	0	0	-0.56334	

Load combination: 1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.61988	
2	0	0	-0.61988	

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.56334	
2	0	0	-0.56334	

Load combination: 1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.56334	
2	0	0	-0.56334	

Load combination: 1.0G + 1.50W (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.31957	
2	0	0	-0.31957	

Load combination: 1.00G + 1.00Q (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.44521	
2	0	0	-0.44521	

Load combination: 1.00G + 1.00Q + ψ_s1.00S (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.44521	
2	0	0	-0.44521	

Load combination: 1.00G + 1.00Q + ψ_s1.00S + ψ_w1.00W (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.44521	
2	0	0	-0.44521	

Load combination: 1.00G + $\psi_0$1.00Q + 1.00S + ψ_w1.00W (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.40752	
2	0	0	-0.40752	

Load combination: 1.00G + $\psi_0$1.00Q + ψ_s1.00S + 1.00W (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.40752	
2	0	0	-0.40752	

Load combination: 1.0G + 1.00W (Service)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.31957	
2	0	0	-0.31957	

Load combination: 1.00G + $\psi_2$1.00Q (Quasi)

Node	Deflection X (mm)	Deflection Z (mm)	Rotation (°)	Co-ordinate system
1	0	0	0.35726	
2	0	0	-0.35726	

Total base reactions

Load case/combination	Force FX (kN)	Force FZ (kN)
1.35G + 1.50Q (Strength)	0	4.8
1.35G + 1.50Q + ψ_S1.50S (Strength)	0	4.8
1.35G + $\psi_0$1.50Q + 1.50S (Strength)	0	4.4
1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)	0	4.8
1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength)	0	4.4
1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength)	0	4.4
1.0G + 1.50W (Strength)	0	2.5
1.00G + 1.00Q (Service)	0	3.4
1.00G + 1.00Q + ψ_S1.00S (Service)	0	3.4
1.00G + 1.00Q + ψ_S1.00S + ψ_W1.00W (Service)	0	3.4
1.00G + $\psi_0$1.00Q + 1.00S + ψ_W1.00W (Service)	0	3.2
1.00G + $\psi_0$1.00Q + ψ_S1.00S + 1.00W (Service)	0	3.2
1.0G + 1.00W (Service)	0	2.5
1.00G + $\psi_2$1.00Q (Quasi)	0	2.8

Element end forces

Load combination: 1.35G + 1.50Q (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.4	0
		2	0	-2.4	0

Load combination: 1.35G + 1.50Q + ψ_S1.50S (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.4	0
		2	0	-2.4	0

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.2	0
		2	0	-2.2	0

Load combination: 1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.4	0
		2	0	-2.4	0

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.2	0
		2	0	-2.2	0

Load combination: 1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.2	0
		2	0	-2.2	0

Load combination: 1.0G + 1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.2	0
		2	0	-1.2	0

Load combination: 1.00G + 1.00Q (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.7	0
		2	0	-1.7	0

Load combination: 1.00G + 1.00Q + ψ_S1.00S (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.7	0
		2	0	-1.7	0

Load combination: 1.00G + 1.00Q + ψ_S1.00S + ψ_W1.00W (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.7	0
		2	0	-1.7	0

Load combination: 1.00G + $\psi_0$1.00Q + 1.00S + ψ_W1.00W (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.6	0
		2	0	-1.6	0

Load combination: 1.00G + $\psi_0$1.00Q + ψ_S1.00S + 1.00W (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.6	0
		2	0	-1.6	0

Load combination: 1.0G + 1.00W (Service)

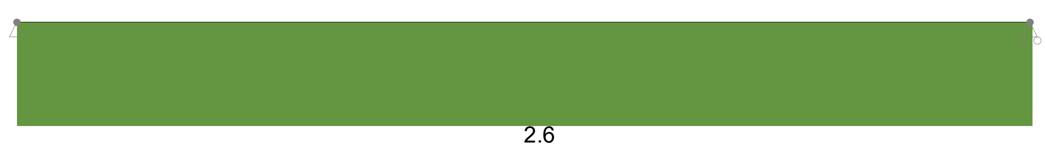
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.2	0
		2	0	-1.2	0

Load combination: 1.00G + $\psi_2$1.00Q (Quasi)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-1.4	0
		2	0	-1.4	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)

Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Member	0	2.4 (max abs)	1.2	0	
	2.16	0		2.6 (max)	1.3
	4.32	-1.2	-2.4	0	

Member - Span 1

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3 γ_M = **1.300**

Member details

Load duration - cl.2.3.1.2 Long-term

Service class - cl.2.3.1.3 2

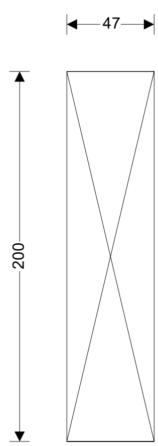
Timber section details

Number of timber sections in member N = **1**

Breadth of sections b = **47** mm

Depth of sections h = **200** mm

Timber strength class - EN 338:2016 Table 1 **C24**



47x200 timber section
Cross-sectional area, A, 9400 mm^2
Section modulus, W_y, 313333.3 mm^3
Section modulus, W_z, 73633 mm^3
Second moment of area, I_y, 31333333 mm^4
Second moment of area, I_z, 1730383 mm^4
Radius of gyration, i_y, 57.7 mm
Radius of gyration, i_z, 13.6 mm
Timber strength class C24
Characteristic bending strength, $f_{m.k}$, 24 N/mm^2
Characteristic shear strength, $f_{v.k}$, 4 N/mm^2
Characteristic compression strength parallel to grain, $f_{c.0.k}$, 21 N/mm^2
Characteristic compression strength perpendicular to grain, $f_{c.90.k}$, 2.5 N/mm^2
Characteristic tension strength parallel to grain, $f_{t.0.k}$, 14.5 N/mm^2
Mean modulus of elasticity, $E_{0.mean}$, 11000 N/mm^2
Fifth percentile modulus of elasticity, $E_{0.05}$, 7400 N/mm^2
Shear modulus of elasticity, G_{mean}, 690 N/mm^2
Characteristic density, ρ_k, 350 kg/m^3
Mean density, ρ_{mean}, 420 kg/m^3

Span details

Bearing length L_b = **75** mm

Consider Combination 4 - 1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)

Modification factors

Duration of load and moisture content - Table 3.1 k_{mod} = **0.7**

Deformation factor - Table 3.2 k_{def} = **0.8**

Bending stress re-distribution factor - cl.6.1.6(2) k_m = **0.7**

Crack factor for shear resistance - cl.6.1.7(2) k_{cr} = **0.67**

System strength factor - cl.6.6 k_{sys} = **1.1**

Check design 2160 mm along span

Check bending moment - Section 6.1.6

Design bending moment $M_{y,d}$ = **2.59** kNm

Design bending stress $\sigma_{m,y,d} = M_{y,d} / W_y$ = **8.264** N/mm^2

Design bending strength $f_{m,y,d} = k_{mod} \times k_{sys} \times f_{m.k} / \gamma_M$ = **14.215** N/mm^2

$\sigma_{m,y,d} / f_{m,y,d}$ = **0.581**

PASS - Design bending strength exceeds design bending stress

Consider Combination 10 - 1.00G + 1.00Q + ψS1.00S + ψW1.00W (Service)

Check design 2160 mm along span

Check y-y axis deflection - Section 7.2

Instantaneous deflection δ_y = **10.8** mm

Quasi-permanent variable load factor ψ_2 = **0.3**

Final deflection with creep $\delta_{y,Final} = 0.5 \times \delta_y \times (1 + k_{def}) + 0.5 \times \delta_y \times (1 + \psi_2 \times k_{def})$ = **16.5** mm

Allowable deflection $\delta_{y,Allowable} = L_{m1\_s1} / 250$ = **17.3** mm

$\delta_{y,Final} / \delta_{y,Allowable}$ = **0.953**

PASS - Allowable deflection exceeds final deflection

TIMBER JOIST ANALYSIS & DESIGN (EN1995-1-1:2004)

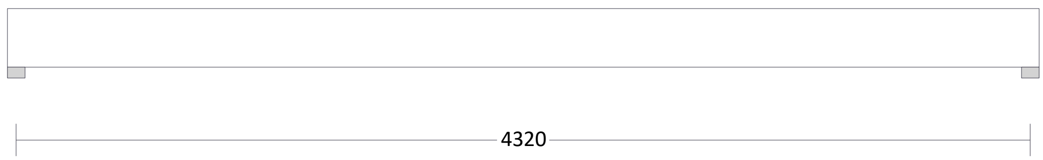
In accordance with EN1995-1-1:2004 + A2:2014 incorporating corrigendum June 2006 and the UK national annex

Tedds calculation version 2.2.00

Joist details

Description 47 x 250 C24 timber joists

Joist spacing s_{Joist} = **300** mm



Forces input on Joist

Vertical permanent load on joist F_{G_Joist}= **3.50** kN/m^2

Vertical imposed load on joist F_{Q_Joist}= **0.75** kN/m^2

Joist loading details

Distributed loads

Vertical permanent load on joist $p_G = F_{G\_Joist} \times s_{Joist}$= **1.05** kN/m

Vertical imposed load on joist $p_Q = F_{Q\_Joist} \times s_{Joist}$= **0.23** kN/m

ANALYSIS

Tedds calculation version 1.0.28

Loading

Self weight included (Permanent x 1)

Load combination factors

Load combination	Permanent	Imposed	Snow	Wind
1.35G + 1.50Q (Strength)	1.35	1.50	0.00	0.00
1.35G + 1.50Q + ψ_s1.50S (Strength)	1.35	1.50	0.75	0.00
1.35G + $\psi_0$1.50Q + 1.50S (Strength)	1.35	1.05	1.50	0.00
1.35G + 1.50Q + ψ_s1.50S + ψ_w1.50W (Strength)	1.35	1.50	0.75	0.75
1.35G + $\psi_0$1.50Q + 1.50S + ψ_w1.50W (Strength)	1.35	1.05	1.50	0.75
1.35G + $\psi_0$1.50Q + ψ_s1.50S + 1.50W (Strength)	1.35	1.05	0.75	1.50
1.0G + 1.50W (Strength)	1.00	0.00	0.00	1.50
1.00G + 1.00Q (Service)	1.00	1.00	0.00	0.00
1.00G + 1.00Q + ψ_s1.00S (Service)	1.00	1.00	0.50	0.00
1.00G + 1.00Q + ψ_s1.00S + ψ_w1.00W (Service)	1.00	1.00	0.50	0.50
1.00G + $\psi_0$1.00Q + 1.00S + ψ_w1.00W (Service)	1.00	0.70	1.00	0.50
1.00G + $\psi_0$1.00Q + ψ_s1.00S + 1.00W (Service)	1.00	0.70	0.50	1.00
1.0G + 1.00W (Service)	1.00	0.00	0.00	1.00

Load combination	Permanent	Imposed	Snow	Wind
1.00G + $\psi_2$1.00Q (Quasi)	**1.00**	**0.30**	**0.00**	**0.00**

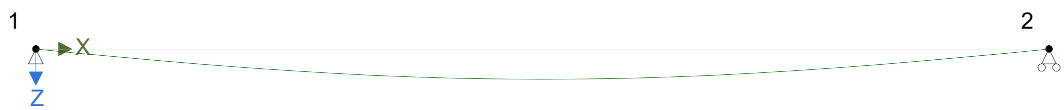
Member Loads

Member	Load case	Load Type	Orientation	Description
Member	Permanent	UDL	GlobalZ	1.05 kN/m at 0 m to 4.32 m
Member	Imposed	UDL	GlobalZ	0.23 kN/m at 0 m to 4.32 m

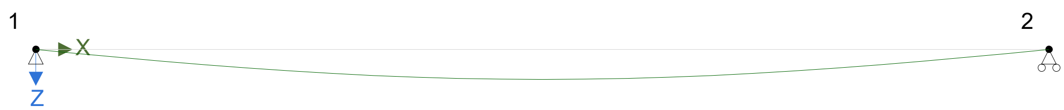
Results

Total deflection

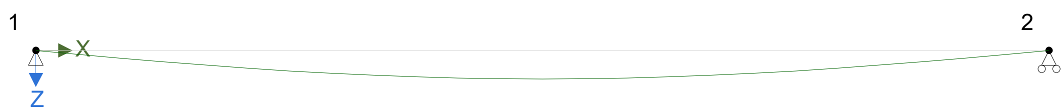
1.35G + 1.50Q (Strength) - Total deflection



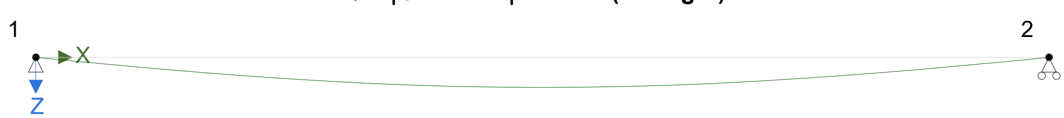
1.35G + 1.50Q + ψ_S1.50S (Strength) - Total deflection



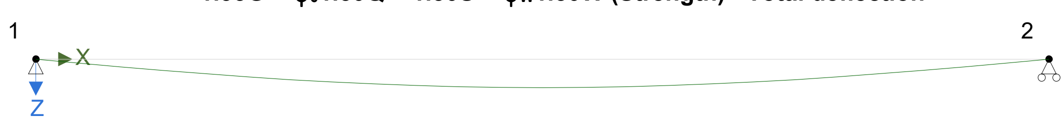
1.35G + $\psi_0$1.50Q + 1.50S (Strength) - Total deflection



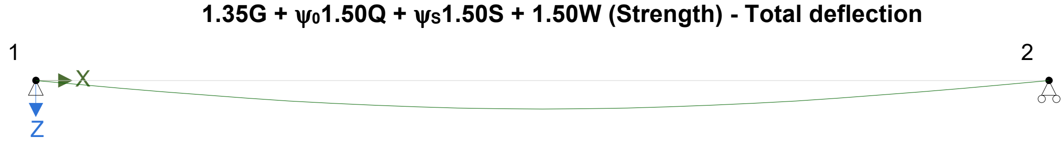
1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength) - Total deflection



1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength) - Total deflection

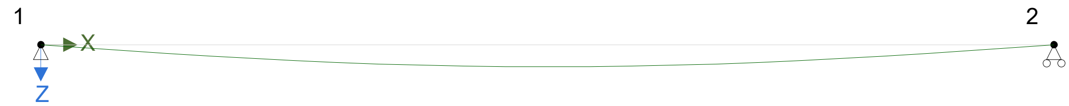


1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength) - Total deflection

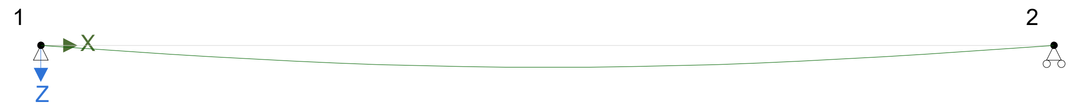


1.0G + 1.50W (Strength) - Total deflection

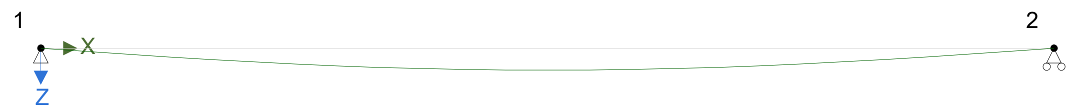
1.00G + 1.00Q (Service) - Total deflection



1.00G + 1.00Q + ψ_S1.00S (Service) - Total deflection

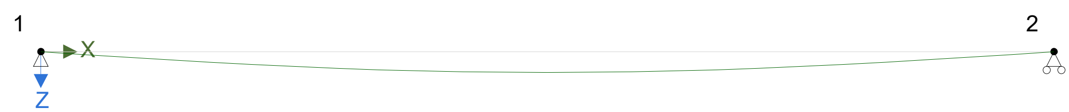


1.00G + 1.00Q + ψ_S1.00S + ψ_W1.00W (Service) - Total deflection

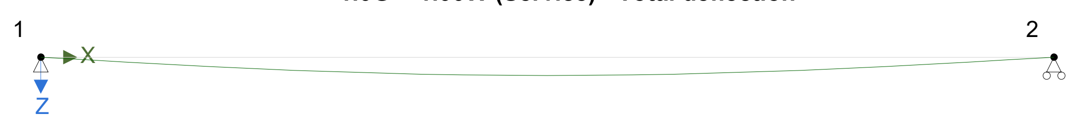


1.00G + $\psi_0$1.00Q + 1.00S + ψ_W1.00W (Service) - Total deflection

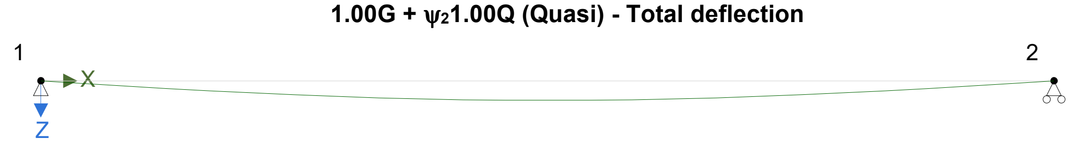
1.00G + $\psi_0$1.00Q + ψ_S1.00S + 1.00W (Service) - Total deflection



1.0G + 1.00W (Service) - Total deflection



1.00G + $\psi_2$1.00Q (Quasi) - Total deflection



Node deflections

Load combination: 1.35G + 1.50Q (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.52046	
2	0	0	-0.52046	

Load combination: 1.35G + 1.50Q + ψ_S1.50S (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.52046	
2	0	0	-0.52046	

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.49151	
2	0	0	-0.49151	

Load combination: 1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.52046	
2	0	0	-0.52046	

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.49151	
2	0	0	-0.49151	

Load combination: 1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.49151	
2	0	0	-0.49151	

Load combination: 1.0G + 1.50W (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.31405	
2	0	0	-0.31405	

Load combination: 1.00G + 1.00Q (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.37838	
2	0	0	-0.37838	

Load combination: 1.00G + 1.00Q + ψ_s1.00S (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.37838	
2	0	0	-0.37838	

Load combination: 1.00G + 1.00Q + ψ_s1.00S + ψ_w1.00W (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.37838	
2	0	0	-0.37838	

Load combination: 1.00G + $\psi_0$1.00Q + 1.00S + ψ_w1.00W (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.35908	
2	0	0	-0.35908	

Load combination: 1.00G + $\psi_0$1.00Q + ψ_s1.00S + 1.00W (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.35908	
2	0	0	-0.35908	

Load combination: 1.0G + 1.00W (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.31405	
2	0	0	-0.31405	

Load combination: 1.00G + $\psi_2$1.00Q (Quasi)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.33334	
2	0	0	-0.33334	

Total base reactions

Load case/combination	Force	
	FX (kN)	FZ (kN)
1.35G + 1.50Q (Strength)	0	7.9
1.35G + 1.50Q + ψ_S1.50S (Strength)	0	7.9
1.35G + $\psi_0$1.50Q + 1.50S (Strength)	0	7.4
1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)	0	7.9
1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength)	0	7.4
1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength)	0	7.4
1.0G + 1.50W (Strength)	0	4.7
1.00G + 1.00Q (Service)	0	5.7
1.00G + 1.00Q + ψ_S1.00S (Service)	0	5.7
1.00G + 1.00Q + ψ_S1.00S + ψ_W1.00W (Service)	0	5.7
1.00G + $\psi_0$1.00Q + 1.00S + ψ_W1.00W (Service)	0	5.4
1.00G + $\psi_0$1.00Q + ψ_S1.00S + 1.00W (Service)	0	5.4
1.0G + 1.00W (Service)	0	4.7
1.00G + $\psi_2$1.00Q (Quasi)	0	5

Element end forces

Load combination: 1.35G + 1.50Q (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-3.9	0
		2	0	-3.9	0

Load combination: 1.35G + 1.50Q + ψ_S1.50S (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-3.9	0
		2	0	-3.9	0

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-3.7	0
		2	0	-3.7	0

Load combination: 1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-3.9	0
		2	0	-3.9	0

Load combination: 1.35G + $\psi_0$1.50Q + 1.50S + ψ_W1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-3.7	0
		2	0	-3.7	0

Load combination: 1.35G + $\psi_0$1.50Q + ψ_S1.50S + 1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-3.7	0
		2	0	-3.7	0

Load combination: 1.0G + 1.50W (Strength)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.4	0
		2	0	-2.4	0

Load combination: 1.00G + 1.00Q (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.9	0
		2	0	-2.9	0

Load combination: 1.00G + 1.00Q + ψ_S1.00S (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.9	0
		2	0	-2.9	0

Load combination: 1.00G + 1.00Q + ψ_S1.00S + ψ_W1.00W (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.9	0
		2	0	-2.9	0

Load combination: 1.00G + $\psi_0$1.00Q + 1.00S + ψ_W1.00W (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.7	0
		2	0	-2.7	0

Load combination: 1.00G + $\psi_0$1.00Q + ψ_S1.00S + 1.00W (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.7	0
		2	0	-2.7	0

Load combination: 1.0G + 1.00W (Service)

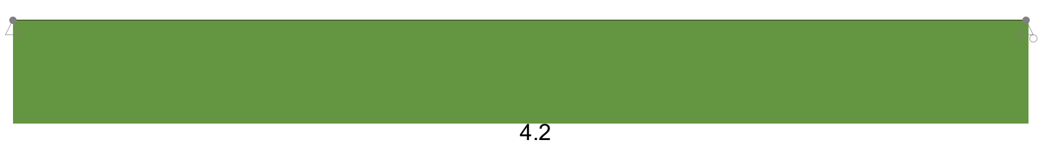
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.4	0
		2	0	-2.4	0

Load combination: 1.00G + $\psi_2$1.00Q (Quasi)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.32	1	0	-2.5	0
		2	0	-2.5	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)

Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Member	0	3.9	2.4	0 (min)	
	2.16	0		4.2 (max)	2.6
	4.32	-2.4	-3.9 (max abs)	0 (min)	

<u>Member - Span 1</u>

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3 γ_M = **1.300**

Member details

Load duration - cl.2.3.1.2 Long-term

Service class - cl.2.3.1.3 2

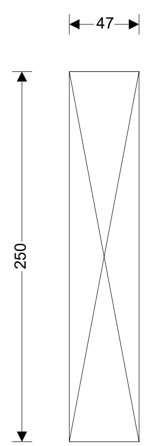
Timber section details

Number of timber sections in member N = **1**

Breadth of sections b = **47** mm

Depth of sections h = **250** mm

Timber strength class - EN 338:2016 Table 1 **C24**



47x250 timber section
Cross-sectional area, A, 11750 mm^2
Section modulus, W_y, 489583.3 mm^3
Section modulus, W_z, 92042 mm^3
Second moment of area, I_y, 61197917 mm^4
Second moment of area, I_z, 2162979 mm^4
Radius of gyration, i_y, 72.2 mm
Radius of gyration, i_z, 13.6 mm
Timber strength class C24
Characteristic bending strength, $f_{m.k}$, 24 N/mm^2
Characteristic shear strength, $f_{v.k}$, 4 N/mm^2
Characteristic compression strength parallel to grain, $f_{c.0.k}$, 21 N/mm^2
Characteristic compression strength perpendicular to grain, $f_{c.90.k}$, 2.5 N/mm^2
Characteristic tension strength parallel to grain, $f_{t.0.k}$, 14.5 N/mm^2
Mean modulus of elasticity, $E_{0.mean}$, 11000 N/mm^2
Fifth percentile modulus of elasticity, $E_{0.05}$, 7400 N/mm^2
Shear modulus of elasticity, G_{mean}, 690 N/mm^2
Characteristic density, ρ_k, 350 kg/m^3
Mean density, ρ_{mean}, 420 kg/m^3

Span details

Bearing length L_b = **75** mm

<u>Consider Combination 4 - 1.35G + 1.50Q + ψ_S1.50S + ψ_W1.50W (Strength)</u>

Modification factors

Duration of load and moisture content - Table 3.1 k_{mod} = **0.7**

Deformation factor - Table 3.2 k_{def} = **0.8**

Bending stress re-distribution factor - cl.6.1.6(2) k_m = **0.7**

Crack factor for shear resistance - cl.6.1.7(2) k_{cr} = **0.67**

System strength factor - cl.6.6 k_{sys} = **1.1**

Check design at end of span

Check compression perpendicular to the grain - cl.6.1.5

Design perpendicular compression - major axis $F_{c,y,90,d}$ = **3.932** kN

Effective contact length $L_{b,ef} = L_b$ = **75** mm

Design perpendicular compressive stress - exp.6.4 $\sigma_{c,y,90,d} = F_{c,y,90,d} / (b \times L_{b,ef})$ = **1.115** N/mm^2

Design perpendicular compressive strength $f_{c,y,90,d} = k_{mod} \times k_{sys} \times f_{c.90.k} / \gamma_M$ = **1.481** N/mm^2

$\sigma_{c,y,90,d} / (k_{c,90} \times f_{c,y,90,d})$ = **0.753**

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear force $F_{y,d}$ = **3.932** kN

Design shear stress - exp.6.60 $\tau_{y,d} = 1.5 \times F_{y,d} / (k_{cr} \times b \times h)$ = **0.749** N/mm^2

Design shear strength $f_{v,y,d} = k_{mod} \times k_{sys} \times f_{v.k} / \gamma_M$ = **2.369** N/mm^2

$\tau_{y,d} / f_{v,y,d}$ = **0.316**

PASS - Design shear strength exceeds design shear stress

Consider Combination 10 - 1.00G + 1.00Q + ψ_S1.00S + ψ_W1.00W (Service)

Check design 2160 mm along span

Check y-y axis deflection - Section 7.2

Instantaneous deflection δ_y = **9.4** mm

Quasi-permanent variable load factor ψ_2 = **0.3**

Final deflection with creep $\delta_{y,Final} = 0.5 \times \delta_y \times (1 + k_{def}) + 0.5 \times \delta_y \times (1 + \psi_2 \times k_{def})$ = **14.2** mm

Allowable deflection $\delta_{y,Allowable} = L_{m1\_s1} / 250$ = **17.3** mm

$\delta_{y,Final} / \delta_{y,Allowable}$ = **0.824**

PASS - Allowable deflection exceeds final deflection

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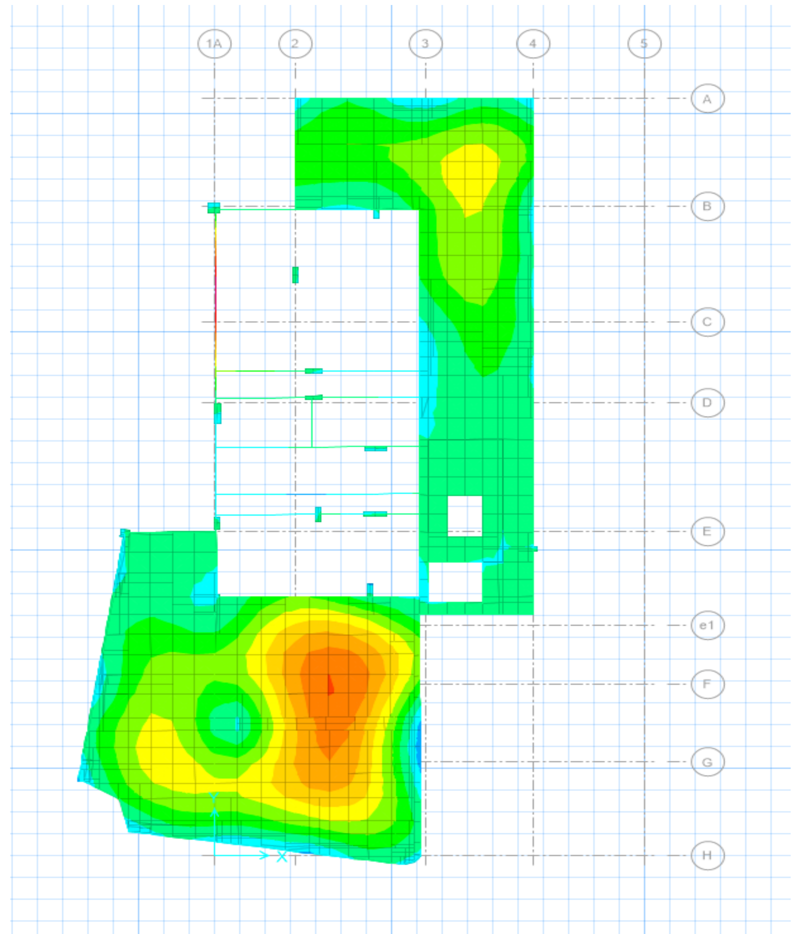
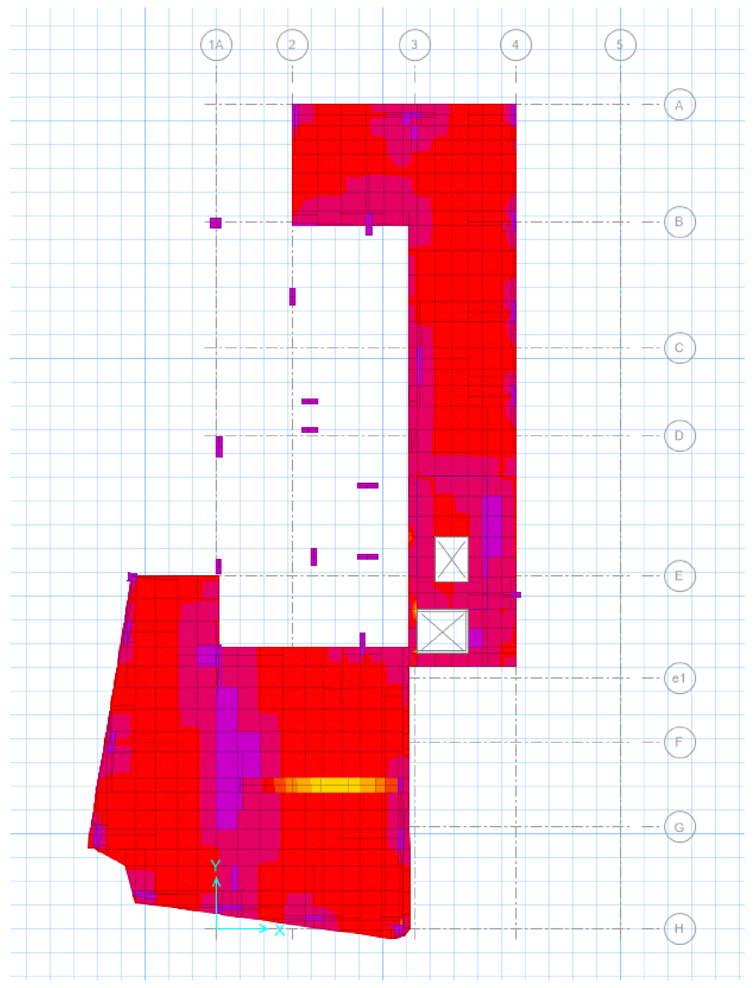
APPENDIX B

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S AND ARCHITECT'S DRAWINGS, SPECIFICATIONS AND RISK REGISTERS.
2. DO NOT SCALE FROM THIS DRAWING. USE ONLY DIMENSIONS AS INDICATED. CHECK ALL SITE DIMENSIONS PRIOR TO PLACING ANY ORDER OR FABRICATION. WHERE A CONFLICT OF INFORMATION EXISTS SEEK CONFIRMATION FROM CONSULTANTS PRIOR TO PROCEEDING FURTHER WITH THE WORKS
3. TEMPORARY STABILITY OF THE EXISTING STRUCTURE AND ANY NEWLY CONSTRUCTED ELEMENTS OF PERMANENT WORKS DURING CONSTRUCTION IS SOLELY CONTRACTOR'S RESPONSIBILITY
4. ONLY DRAWINGS AND SPECIFICATIONS ISSUED FOR **CONSTRUCTION** CAN BE USED FOR THE WORKS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO SEEK THE INFORMATION FROM CONSULTANTS.
5. ALL PROPRIETARY ITEMS TO BE INSTALLED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS AND SPECIFICATIONS
6. ALL WATERPROOFING SUCH AS TANKING DETAILS, DAMP PROOF MEMBRANES, DAMP PROOF COURSES, CAVITY TRAYS ETC. ARE TO BE INSTALLED AS PER ARCHITECT'S DETAILS

FIFTH FLOOR SLAB WITH GREEN ROOF

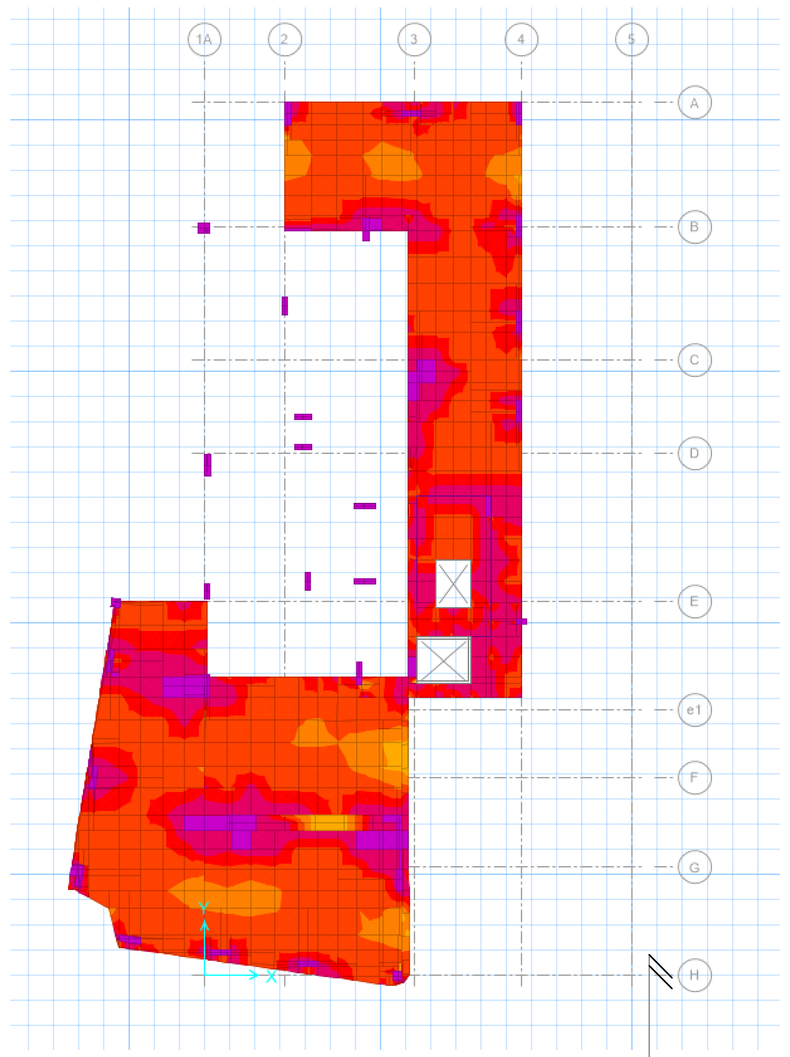


MAXIMUM DEFLECTION OF APPROXIMATELY 22mm
WITHIN THE ACCEPTABLE LIMIT OF DEFLECTION



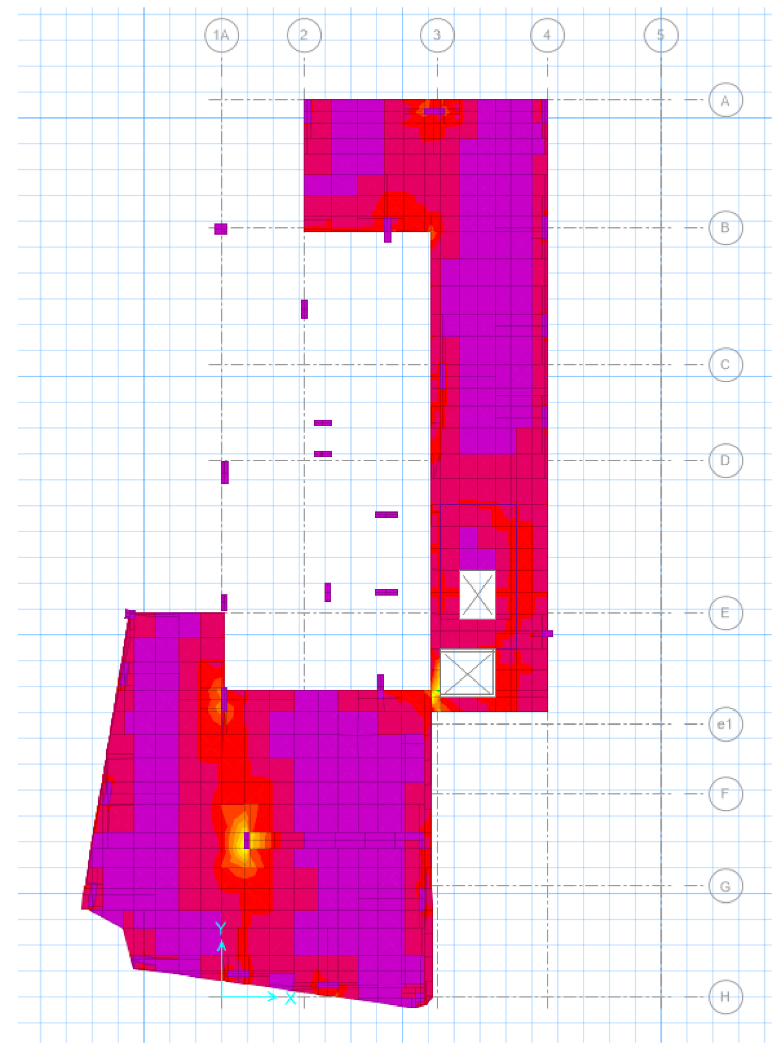
REINFORCEMENT IN DIRECTION B1
MAXIMUM REINFORCEMENT REQUIRED:

Max = 3641.665 mm2/m at [8.031 m, 0.33626 m];



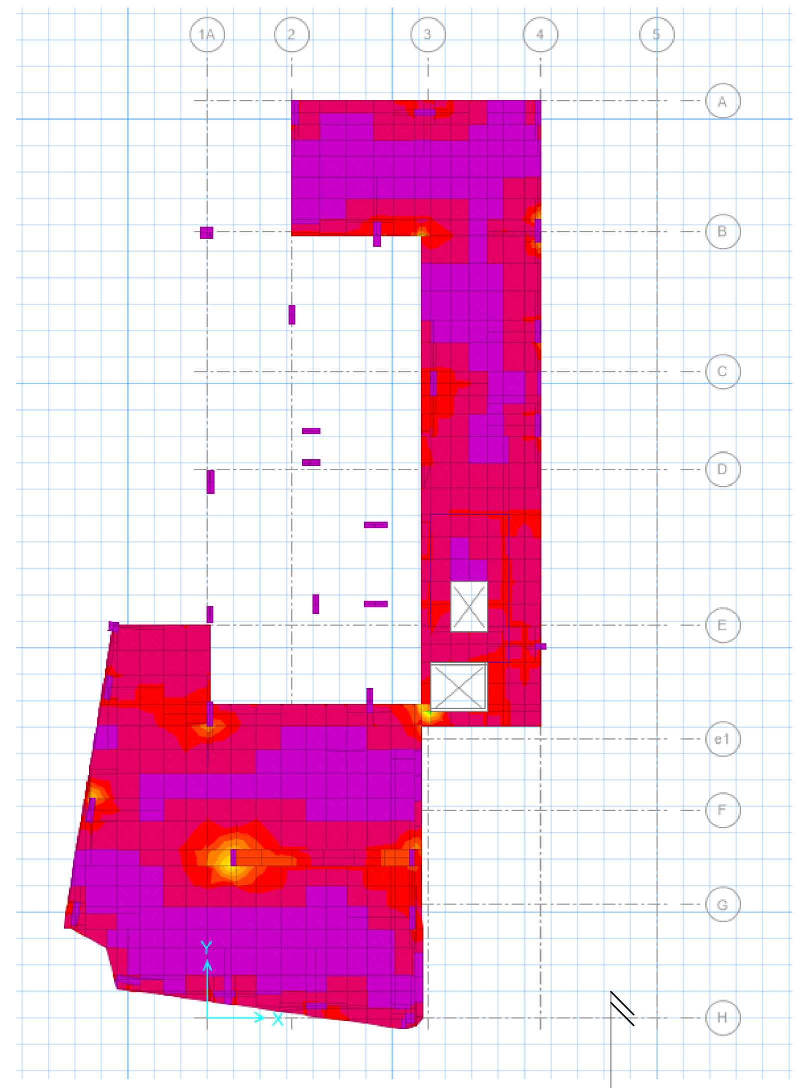
REINFORCEMENT IN DIRECTION B2
MAXIMUM REINFORCEMENT REQUIRED:

Max = 2543.011 mm2/m at [8.031 m, 0.33626 m];



REINFORCEMENT IN DIRECTION T1
MAXIMUM REINFORCEMENT REQUIRED:

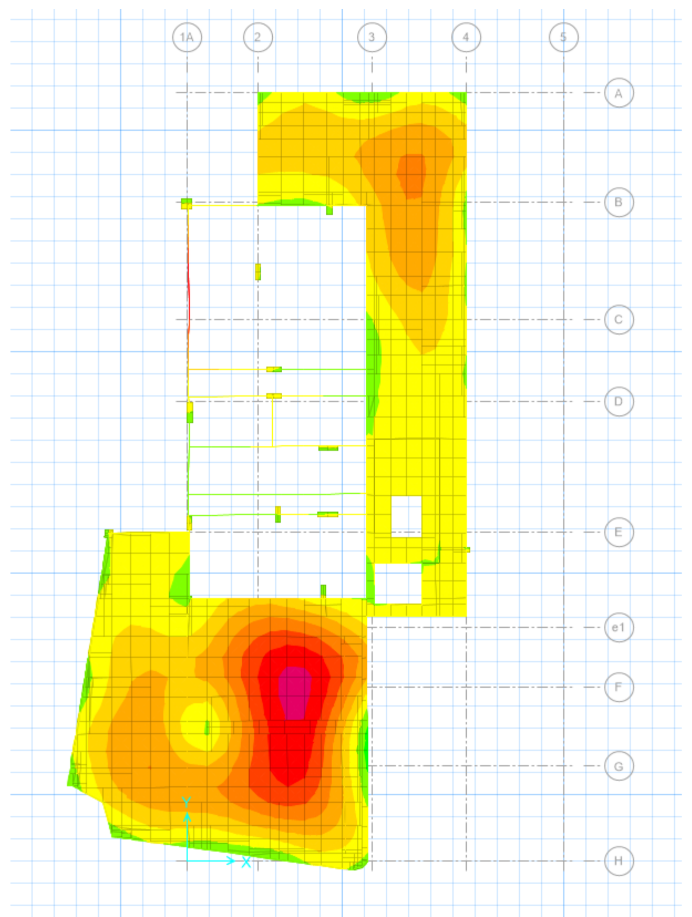
Max = 4109.231 mm2/m at [0.9169 m, 5.845 m];



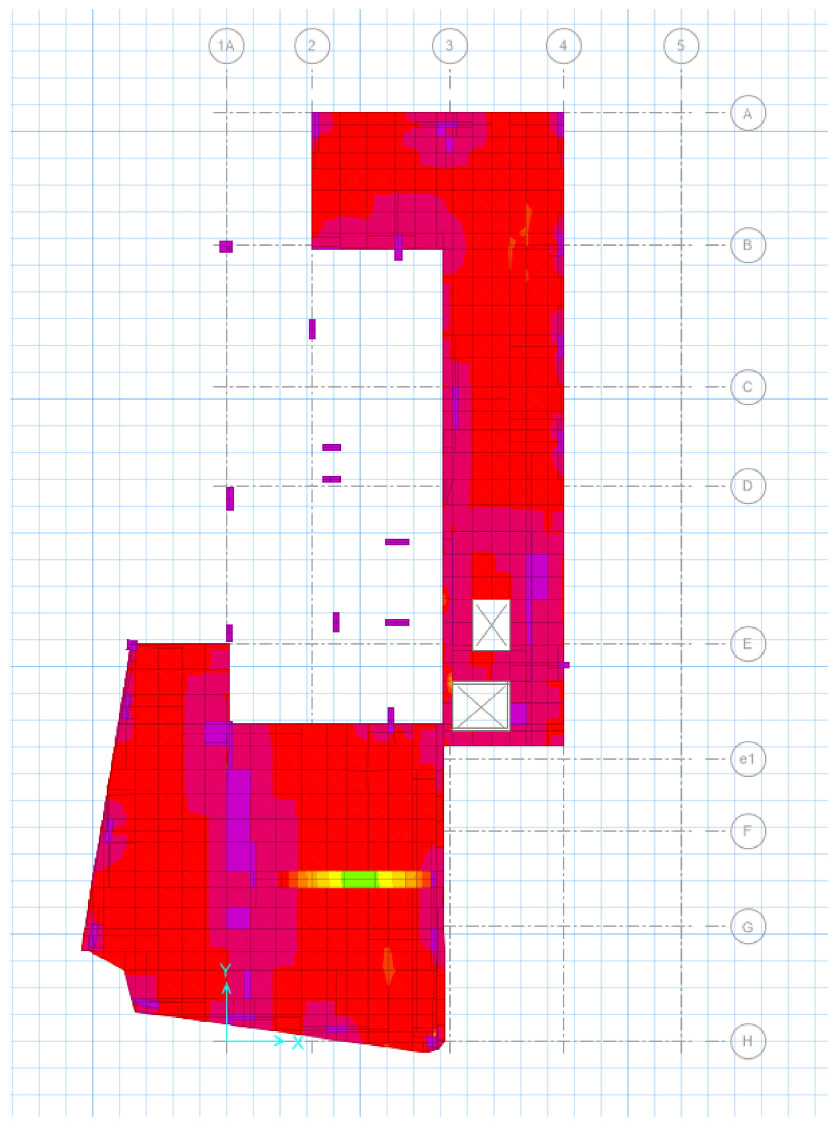
REINFORCEMENT IN DIRECTION T2
MAXIMUM REINFORCEMENT REQUIRED:

Max = 3724.216 mm2/m at [0.9169 m, 5.845 m];

FIFTH FLOOR SLAB WITH COMBINED GREEN AND BLUE ROOF

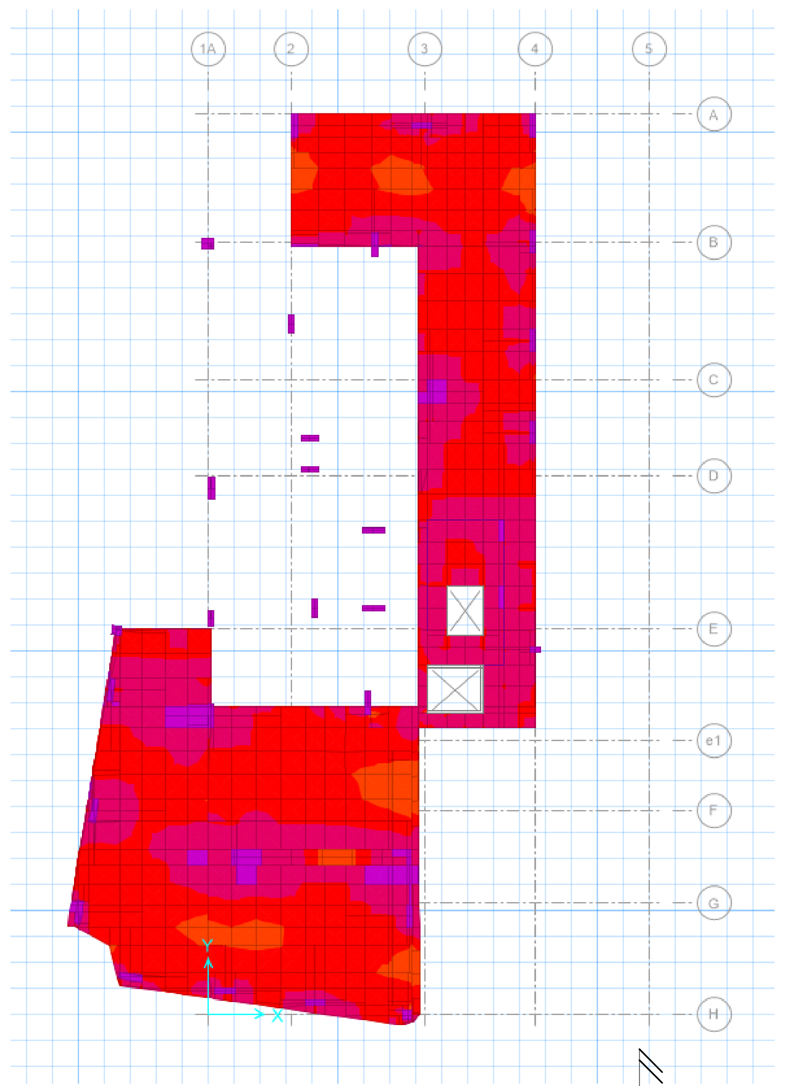


MAXIMUM DEFLECTION OF APPROXIMATELY 28mm
EXCEEDING THE ALLOWABLE LIMIT OF DEFLECTION



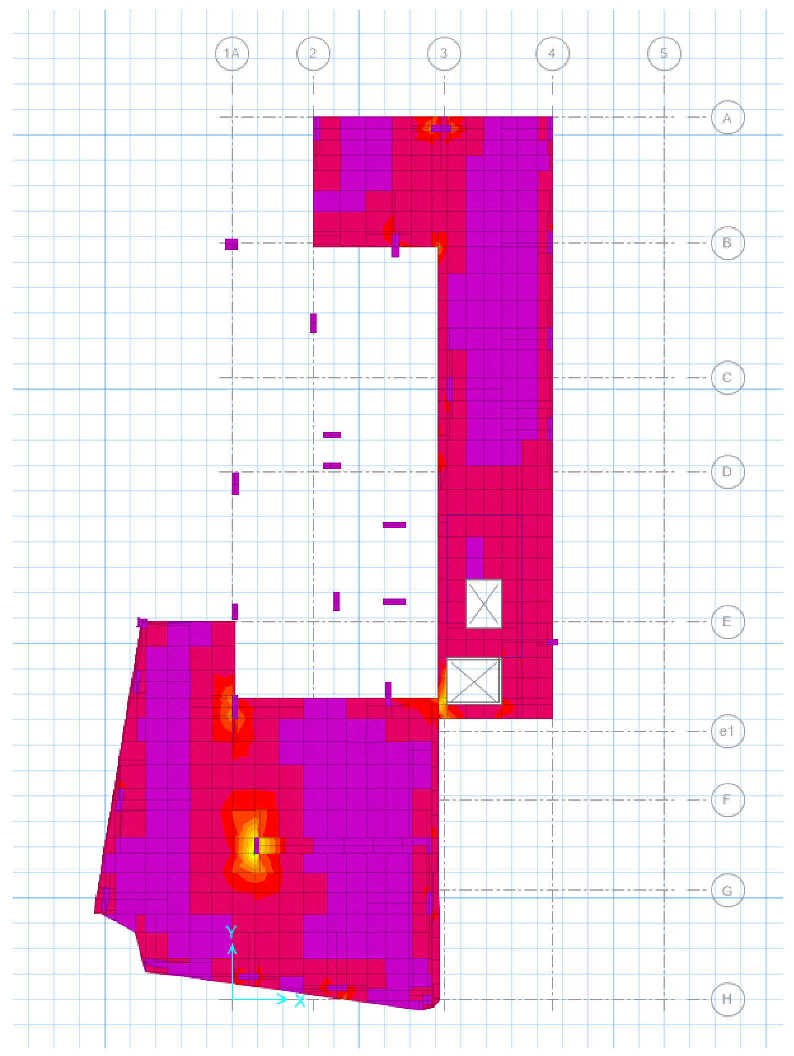
REINFORCEMENT IN DIRECTION B1
MAXIMUM REINFORCEMENT REQUIRED:

Max = 4954.261 mm2/m at [8.031 m, 0.33626 m];



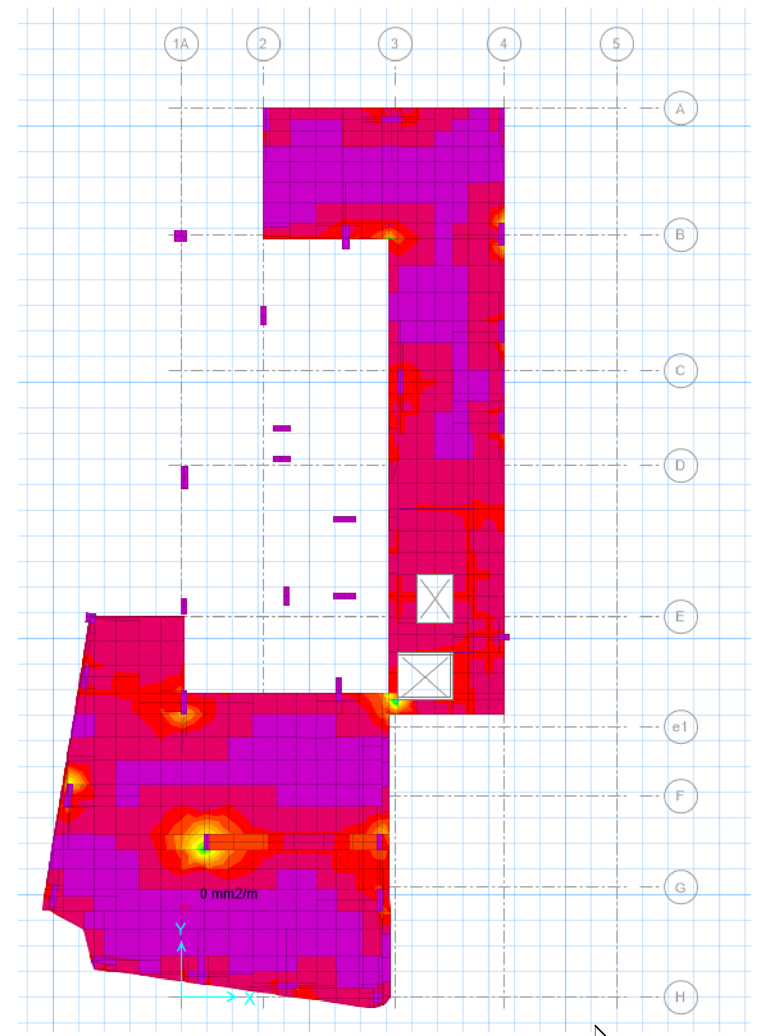
REINFORCEMENT IN DIRECTION B2
MAXIMUM REINFORCEMENT REQUIRED:

Max = 3390.12 mm2/m at [8.031 m, 0.33626 m];



REINFORCEMENT IN DIRECTION T1
MAXIMUM REINFORCEMENT REQUIRED:

Max = 5369.028 mm2/m at [0.9169 m, 5.845 m];



REINFORCEMENT IN DIRECTION T2
MAXIMUM REINFORCEMENT REQUIRED:

Max = 5014.265 mm2/m at [-4.54878 m, 8.46128 m];

CONCLUSION:

1. INCREASE IN THE LOADING AT FIFTH FLOOR LEVEL WILL REQUIRE SIGNIFICANT INCREASE IN THE TONNAGE OF REINFORCEMENT TO MANAGE THE DEFLECTION OR ALTERNATIVELY THE DEPTH OF THE SLAB WILL REQUIRE TO BE INCREASED TO MINIMUM OF 250mm.
2. THE AREAS WITH PEAK REINFORCEMENT REQUIRED WILL REQUIRE SIGNIFICANT INCREASE IN THE TONNAGE OF REINFORCEMENT BARS TO BE PROVIDED.
3. PUNCHING SHEAR REQUIREMENT COULD GOVERN AND THE SLAB MAY REQUIRE TO BE FURTHER THICKENED ALONG WITH PROVISION OF PUNCHING SHEAR REINFORCMENT.

rev	date	description	by	checked
P01	2020.02.13	ISSUED FOR INFORMATION	SS	PG

PROJECT TITLE:
18-22 HAVERSTOCK HILL

CLIENT:
VABEL

PROJECT No: E0648
DRAWN: SS
CHECKED: PG

DRAWING TITLE:
FIFTH FLOOR SLAB ASSESSMENT - BLUE ROOF

DRAWING No:
E0648-EEE-00-XX-DR-S-9032

STATUS DESCRIPTION:
FOR INFORMATION

REV: P01
SCALE: NTS @A1

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