



Trinity Group Ltd

Site Location Information

Project Title:
**New Centre of Excellence
for Construction Training**

Document Number:
P001-TRN-ZZ-S1-DA-X-001

Student Information :-
Timothy Mills - 2206144

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I1	11/02/2025	First Issue	TM (2206144)	CJ	NM

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1) Site Location Description

The proposed development is an extension of the University of Wales Trinity Saint David (UWTSD) SA1 Campus, located within Swansea Harbour. The existing campus currently comprises three buildings, IQ Building, Y Fforwm, and the IM Building.

The proposed site address is :-

Adjacent to Y Fforwm, King's Road, SA1 Swansea Waterfront, Swansea, Wales, SA1 8EW.

The development forms part of the wider brownfield regeneration of the former docklands and will provide UWTSD with a state-of-the-art facility aimed at enhancing construction techniques and product development, making the scheme a key component of the SA1 regeneration area.

For project coordination systems, refer to P001-TRN-V1-ZZ-MS-X-001 – BIM Execution Plan, Section 8.

2) Site History

The proposed site at the Prince of Wales Dock is an area with a strong industrial and maritime heritage. The dock was developed in response to the rapid growth of industrial output in the Swansea region during the late 19th century.

Construction began in 1879 under the direction of the Swansea Harbour Trust, and the dock was officially opened on 18 October 1881 by the Prince and Princess of Wales, from where it takes its name. An expansion of maritime trade led to further development of Swansea's docklands in the early 20th century. The extensions to the larger King's Dock were completed in 1909, followed by additional expansions to the Queen's Dock, which opened in 1920. Together, these docks played a significant role in supporting the region's industrial economy for several decades. (Swansea and Port Talbot Docks, no date)

By 1971, changes in shipping practices and industrial decline led to the closure of the docks. In the years that followed, the area underwent a major transformation and was revitalised as the Maritime Quarter, marking a shift from heavy industry to mixed-use urban regeneration. (Wikipedia, 2026. Swansea docks)



*Image 1 - Ariel View of Swansea Docks
(Swansea and Port Talbot Docks, no date)*

The regeneration of the Swansea Docks has continued through the SA1 redevelopment, which has delivered a range of notable projects including South Quay Apartments, Meridian Quay, J Shed, and several university buildings such as Y Fforwm, IQ Building & most recently the IM building. The continuation of the SA1 redevelopment has been to create a vibrant mixed-use waterfront neighbourhood, providing approximately 2,000 new apartments, over 23,200m² of educational space and 65,000m² of office accommodation, whilst providing more than 2,900 new jobs in the regeneration. (Wikipedia, 2026. SA1 Swansea Waterfront)

3) Site Location Options

The overall proposed site location is outlined red in image 2. The proposed overall site area provided by ACE Capital projects LTD is 11,475m². The location of the site is within proximity of the UWTSD buildings, so the construction will have to consider the interaction with public both during and after construction.

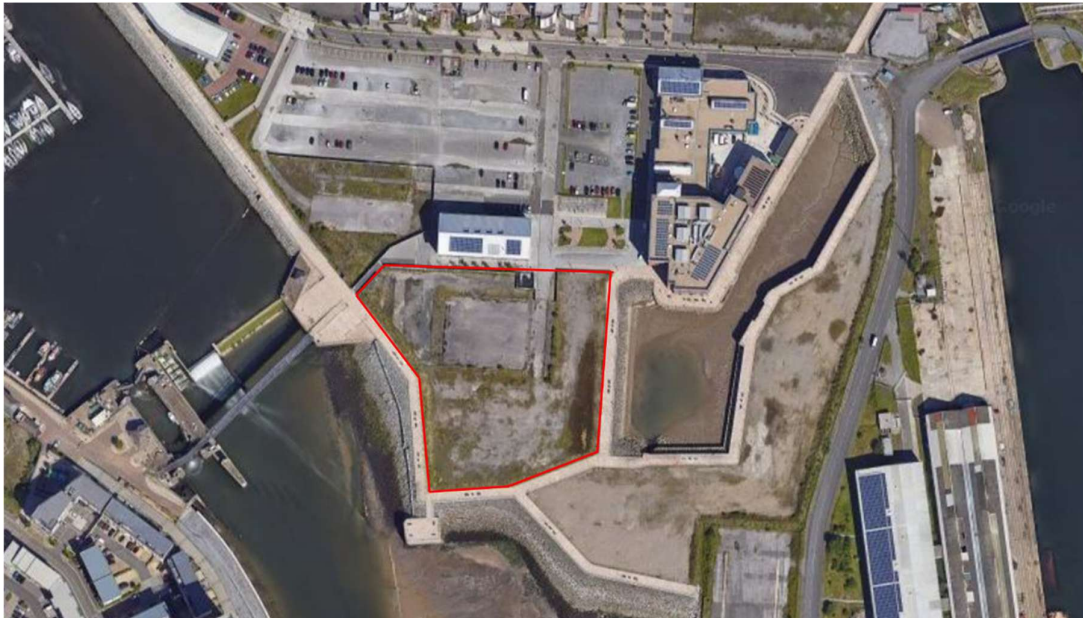


Image 2 - Available Site Location

In line with the client's requirements, the available area is more than sufficient to accommodate the proposed development. A thorough assessment has been conducted to identify the most suitable location for the building within this space to maximise the proposed area's. Three potential site locations have been evaluated, each presenting its own set of advantages and disadvantages.

3.1) Site Location - Option 01

The Site Location – Option 01 is highlighted in red in Image 3, covers an area of 4,145 m².

Key features of this location include its proximity to the existing university campus, ensuring continued accessibility during and after construction, while allowing for future development with minimal disruption. The site is highly visible from Trafalgar Bridge, providing a prominent visual statement for the university.

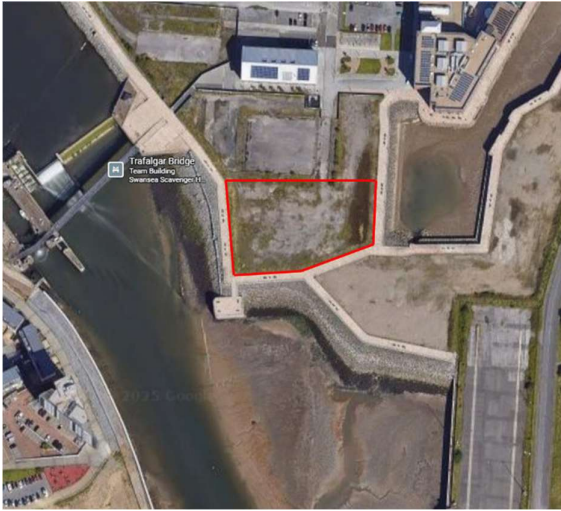
While its proximity to Y Fforwm may present some constructability constraints, it also offers significant advantages, as all essential services are readily available and can be extended or enhanced to support the proposed development.



Image 3 - Proposed Site Location – Option 01

3.2) Site Location - Option 02

The Site Location – Option 02 highlighted in red in Image 4, covers an area of 5,285 m².



Key features of this location include the largest available site area, providing the university with the greatest potential for a spacious and flexible building footprint.

The site's position offers the greatest visibility from both Trafalgar Bridge and across the River Tawe, presenting an opportunity for the university to establish a distinctive architectural presence.

However, as the proposed building is the furthest from the existing campus structures, two smaller parcels of land remain on either side of the roadway. Development of these parcels in the future could potentially cause disruption to university operations.

Image 4 - Proposed Site Location - Option 02

3.3) Site Location - Option 03

The Site Location – Option 03 highlighted in red in Image 5, covers an area of 3,065 m².

Key features of this location include its suitability for future development, offering the largest potential land extension. It is also the closest to the Y Fforwm, IM, and IQ buildings, providing strong connectivity and ease of integration with the existing university campus.

However, this site represents the smallest of the three proposed locations and has the narrowest footprint, which may limit flexibility in building design.



Image 5 - Proposed Site Location - Option 03

4) Proposed Site location

Considering the three proposed site options, 'Proposed Site Location 01' offers the greatest potential for future development, facilitates efficient construction, and minimizes disruption to the ongoing operations of the university.



Image 6 - Proposed Site Location

The proposed area provides many positive factors such as sufficient space that meets the project specifications and allows for the installation of a south facing roof, ideal for renewable technologies such as solar panels.

The site accommodates future development and potential expansion of the UWTSD campus.

During the construction the proposed area provides additional space for construction facilities, such as site offices, welfare facilities & material storage areas (Highlighted in blue outline).

Its accessibility supports the efficient delivery of construction materials, and the available space can accommodate potential crane/piling operations. The site maintains strong connectivity with all existing UWTSD buildings, enhancing integration across the campus upon completion.

However, there are also several disadvantages associated with this location. The proximity of construction activities to Y Fforwm may create challenges for site operations, while access to the site is constrained by routes through university grounds.

Additionally, the site's location near Trafalgar Bridge increases the likelihood of public interaction, which could require additional safety measures and careful management during construction. These factors will be carefully considered to mitigate potential disruption to both the university and the public.

5) Proposed SA1 Masterplans by ATPA

In 2020, ATPA Ltd was commissioned to develop a masterplan to demonstrate the potential of the available land within the docks. The masterplan illustrates the feasible scale of development for the area, providing a clear rationale for reducing the project footprint from the original 11,475 m² to 4,145 m². This adjustment allows for additional development surrounding the proposed 'Centre of Excellence for Construction Training', positioning the building as a prominent focal point within the area (ATPA Ltd, 2020)



Image 7 - Plan View of Master Plan (ATPA Ltd, 2020)



Image 8 - Isometric View of UWTSO Campus (ATPA Ltd, 2020)



Image 9 - Isometric View of Master Plan (ATPA Ltd, 2020)

6) References

- 1) ATPA Ltd (2020) *Swansea master plan*. Available at: <https://atp-a.com/project/swansea-master-plan/> (Accessed: 11 February 2026) Swansea and Port Talbot Docks (no date) *History of Swansea Docks*. Available at: <http://www.swanseadocks.co.uk/docksnewsite/history.html> (Accessed: 11 February 2026)
- 2) *Wikipedia* (2026) *Swansea docks*. Available at: https://en.wikipedia.org/wiki/Swansea_docks (Accessed: 11 February 2026)
- 3) *Wikipedia* (2026) *SA1 Swansea Waterfront*. Available at: https://en.wikipedia.org/wiki/SA1_Swansea_Waterfront (Accessed: 11 February 2026)



Trinity Group Ltd

Proposed Design Report

Project Title:
**New Centre of Excellence
for Construction**

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1) Client Specifications

ACE Capital Projects Ltd has identified the following key requirements for the proposed Centre of Excellence for Construction Training:

Provision of one to two large workshop spaces, dedicated to:

- Modern Construction Area.
- Historic and Traditional Construction Area.
- Teaching and learning accommodation, including flexible classroom spaces.
- A dedicated IT / PC suite to support digital learning.
- On-site parking facilities appropriate to the operational needs of the building.
- Welfare facilities.
- Meeting and collaboration spaces for staff, students, and external stakeholders.
- A sustainable design approach, incorporating energy efficiency and low-carbon principles.
- Full compliance with Building Information Modelling (BIM) requirements.
- Project delivery within a 22-month programme, from inception to completion (Target completion date of August 2027.)

2) Proposed Design

Given that the client brief allows for some flexibility, the design approach has been developed to both present and future needs. The proposal aims to maximise the efficient use of the available site area whilst safeguarding for potential future expansion and development.

Consideration has been given to maintaining the uninterrupted day to day operation of the university throughout the lifecycle of the project. In addition, the design respects the historical context of the site and integrates sustainable principles that align with its social and cultural significance. The outcome is a balanced solution that supports functional performance, long-term adaptability, and contextual sensitivity.

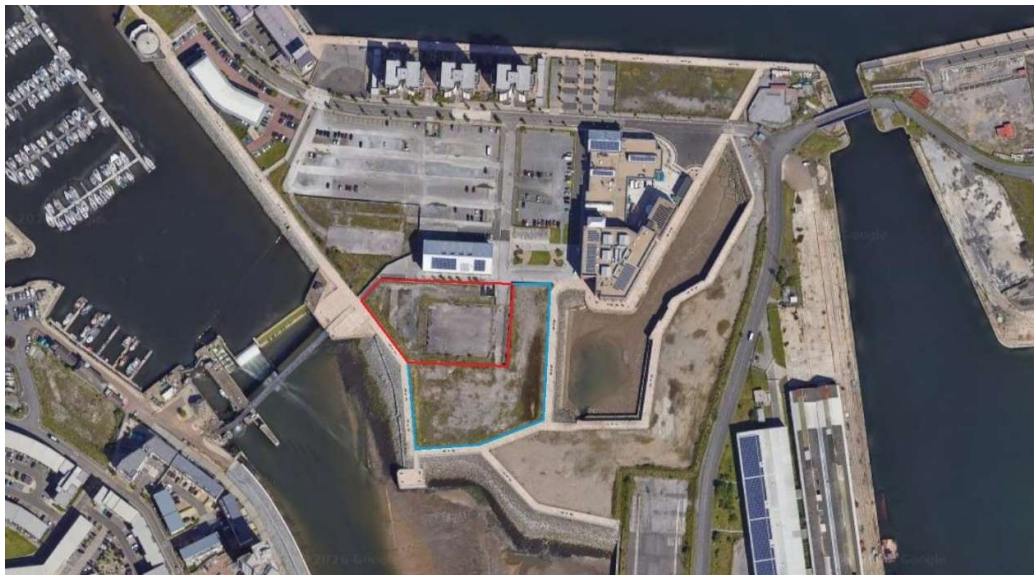


Image 1 - Proposed Site Location

For site location details refer to P001-TRN-ZZ-S1-DA-X-001- Site Location Information.

2.1) Drawings

The following drawings are related to the design of the proposed “New Centre of Excellence for Construction Training”.

Table 1 - Reference Drawing Table

Document Number	Document Name
P001-TRN-V1-L0-DR-A-001-R1	GROUND FLOOR - PLANS
P001-TRN-V1-L1-DR-A-001-R1	FIRST FLOOR - PLANS
P001-TRN-V1-R1-DR-A-001-R1	ROOF - PLANS
P001-TRN-V1-ZZ-DR-A-001-R1	ELEVATION VIEWS - NORTH & EAST
P001-TRN-V1-ZZ-DR-A-002-R1	ELEVATION VIEWS - SOUTH & WEST
P001-TRN-V1-ZZ-DR-A-003-R1	FLOOR LEVELS - ISOMETRIC VIEW

2.2) Proposed Space Reservations

The proposed design has the following space reservation: -

- 2no. Workshops for Modern & Traditional Construction Area's.
(160m² per workshop / Total Area = 320m²)
Including a storage room per area. (13m² each)
- 1no. General Workshop for additional practical learning space (Total Area = 78m²)
(This area can be utilised for additional storage or an area for mechanical services to be located)
- 3no. Classrooms with availability for 24 student per classroom.
(Per Classroom = 78m² / Total Area = 234m²)
- 1no. IT Room with availability for 36 workstations. (Total Area = 118m²)
- Large communal area for general seating, student interaction, available for any potential university functions. (Total Area = 249m²)
- Welfare facilities including, Male, Female & Disabled Toilets.
(Male = 17m² / Female = 17m² / Disabled = 5m²)
- 2no. Meeting Rooms. That can accommodate 10 people per room.
(Per Room = 27 m² / Total Area = 54 m²)
- On-site parking facilities which include availability for 35 vehicles of which 6 are disabled bays.

For all room area's refer to drawing numbers: -

P001-TRN-V1-L0-DR-A-001-R1 - GROUND FLOOR – PLANS

P001-TRN-V1-L1-DR-A-001-R1 - FIRST FLOOR – PLANS

P001-TRN-V1-R1-DR-A-001-R1 - ROOF - PLANS

2.3) Services requirements

To facilitate the proposed construction requires the following services: -

- Water supply – Supply from Dwr Cymru Welsh Water (DCWW)
- Foul Sewer Drainage – Connection to Public Sewer - DCWW
- Surface Water Drainage – Strategy to align with Swansea Council (SuDS Approval) during planning approval / Natural Resource Wales if design to go into the water course.
- Electrical Supply – Extension/Increase capacity of existing UWTSD campus's – National Grid
- Gas Supply – Wales & West Utilities provide connection and assess network capacity.
- Telecommunications & Data – Openreach provide and install extension/increase capacity.

Refer to section XX for details on the delivery of the services to the proposed site location.

2.4) Accessibility

The primary access to the site will be from the current university entrance off Island Road, using the road extension that was previously built to allow for future development. This road will be extended further and routed around the proposed Centre of Excellence for Construction, providing access to the new car park, which will include 29 standard parking bays and 6 accessible bays.

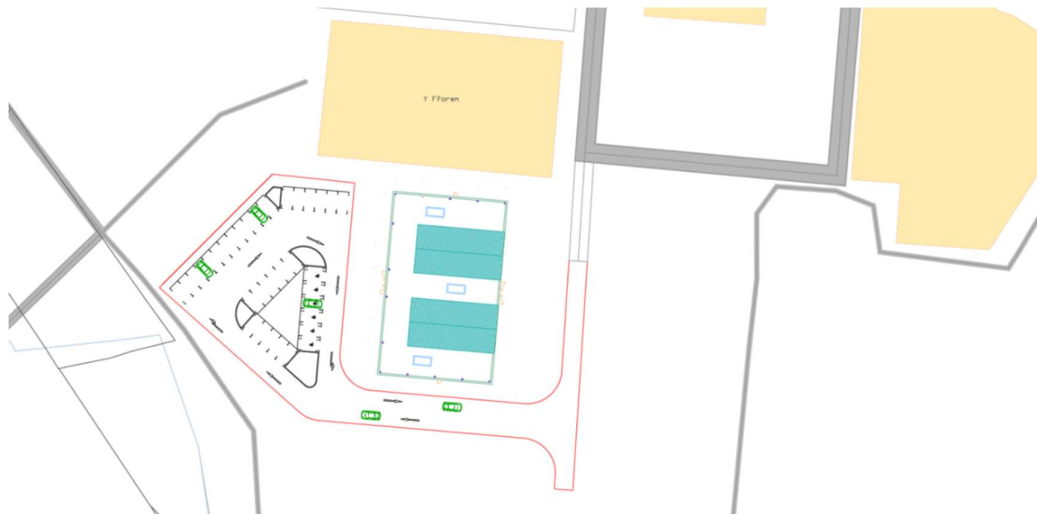


Image 2 - Proposed Site Layout

The main entrances to the building will be located on both the west and east sides. Each entrance will feature a revolving door, along with an automatic door to provide accessible entry for wheelchair users and others who require step-free access.

Drop kerbs will be installed between the roadway and kerb to ensure safe and easy access. From the kerb to the main entrance, the pathway will have a gentle slope of 1:150 minimum, allowing surface water to drain away from the building while still providing smooth and comfortable access from outside to inside.

Inside the building, there are two main ways to travel from the ground floor to the first floor: the main staircase and a lift. Together, these provide suitable access for all users, including those with disabilities.

3) Flexibility of Use

The proposed design incorporates a steel framed structural system arranged in a grid, which provides a high degree of flexibility for future use. This construction method facilitates the addition of structural members, allowing for subdivision of the large workshop areas into two separate floors. Such adaptability allows the facility to be reconfigured to accommodate additional educational spaces or office accommodation in response to potential changing needs.

Alternatively, the expansive open-plan workshop areas could be repurposed as commercial units and made available to external organisations as leasable industrial/workshop spaces. Similarly, the existing classrooms could be converted into office accommodation with minimal structural intervention.

In the current design, it could be subdivided into four independent office units, made up of two office spaces at ground floor level which incorporates the former workshop areas and two at first floor level, comprising office space only.

To facilitate this conversion, modifications would be required to provide dedicated welfare facilities within each individual office unit, along with the installation of additional internal partitions to ensure appropriate segregation between spaces. In Image 2 & 3 highlights the modifications that would be required to accommodate the change of use.

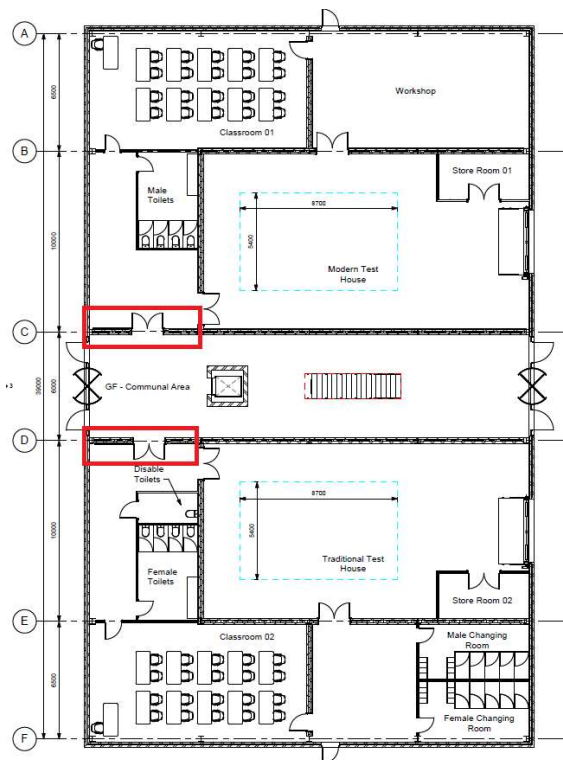


Image 3 - Ground Floor Modifications

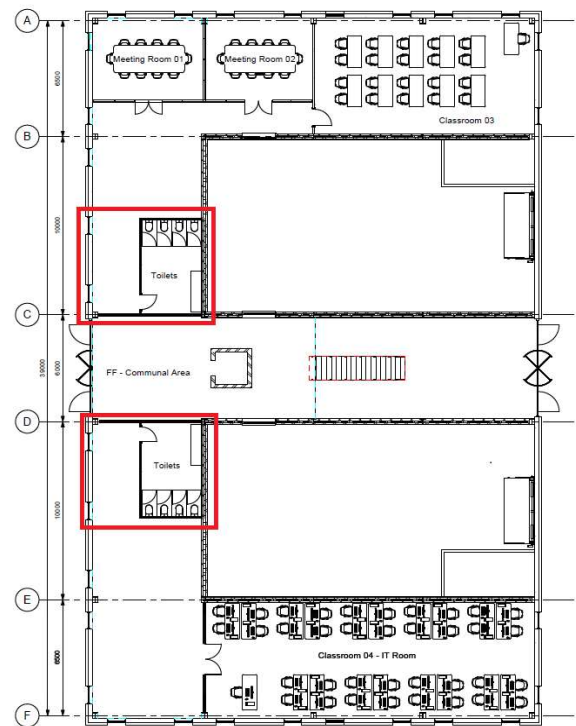


Image 4 - First Floor Modifications

4) Aesthetics & Associated U-Values

During the design of the Centre of Excellence for Construction, the main consideration for the external aesthetic was to ensure that the history of the site was at the forefront in the visual effect. From the historic image below, it shows how the area was used during the industrial revolution as the main docking location for all railway carriages.

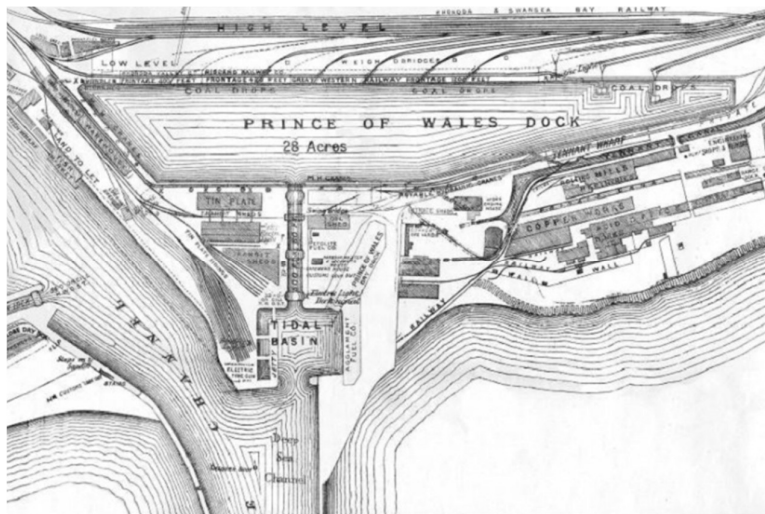


Image 5 - Prince of Wales Dock as at 1898 (Swansea and Port Talbot Docks, 2026)

From this, the proposed design was done to align with the industrial storage unit, with the tall aluminium pre insulated cladded panels. Kingspan QuadCore Louvre wall panel gives the aesthetic look required for the building whilst maintaining the required energy performance for the walls U-Values of 0.15 W/m²K at a depth of 120mm. (Kingspan Insulated Panels, 2026)

Refer to Section 5 - Image 2 for a visual interpretation of the cladding provided.

The continuation of aligning the design with the history of the site involves the narrow tall windows, that range from the ground floor to ceiling level which was done to give the impression of the railway tracks running in unison. Maintaining the visual aspect, providing triple glazed window system reduces the heat loss during the winter periods whilst allowing air flow for cooling in the summer.

The incorporation of the two roller shutter doors gives the envisage of what would have been the access points for the railway karts. Bluseal Limited provide an insulated sectional door that complies with a U-Value of 0.031 W/m²K at a leaf thickness of 70mm. (Bluseal Insulated Rigid Door, 2026)

The pitched roof construction echoes the wall construction which maintains the overall shed like build but for the flat roof section a green roof design has been provided for its thermal mass ensuring that the energy performance is at the forefront, whilst adding a green environment to a heavily industrialised area. This is made up from a metal rib deck floor (ComFlor80) supplied by a local manufacturer, Tata Steel in Port-Talbot. Vapor Control Layer, 150mm PIR Insulation (Rigid insulation boards), Root-resistant waterproof membrane to restrict the vegetation growing internally, drainage layer made up of aggregate, Filter layer which prevents the drainage layer from blockage, 120mm lightweight engineered soil and a vegetation layer made up of wildflowers. This construction would typically provide a u-value of 0.15W/m2K.

5) Alternative Design Options

5.1) Design Concept 01- The Overhang

The overhang design comprises of a large canterlever section which would be prominent feature, the direction of this could either overhand in the west direction overseeing the River Tawe which will provide a statement when viewing the building from the Trafalgar Bridge.

Alternatively the overhand could be in the east direction making it a satement feature for the UWTSD campus communal area. Asthetically this proposal gives the best visual appearance against the other two concepts.

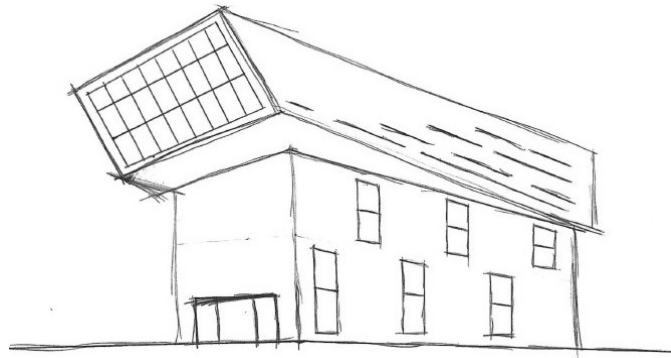


Image 6 - The Overhang - Isometric View

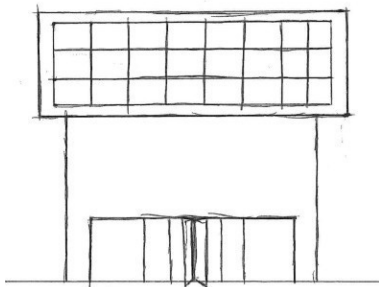


Image 7 - The Overhang - Front Elevation

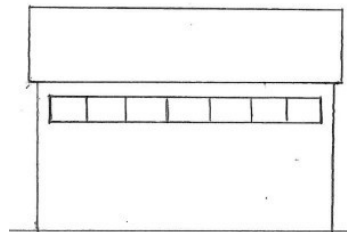


Image 8 - The Overhang - Rear Elevation

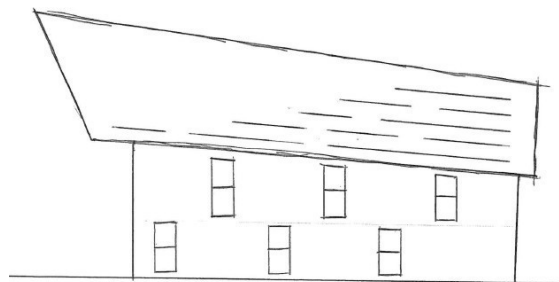


Image 9 - The Overhang - Side Elevation

The primary disadvantages for this construction is the inkeeping with the surrounding area, with no consideration of its history.

The overhang could be seen as an obstruction to future development given the limitation of access underneath it (Dependant on the canterlever length). This then means the scale of the building would be larger than required given the requirement to increase the height, also effecting the foundations sizes and increased piling depth, causing increased costs of design and construction.

5.2) Design Concept 02 - The Stacked Box's

The stacked box's design gives the contrast that 4 Rectangular shaped boxes, 2 layed ontop of the others, whilst having them all staggered to give them different visual contrast.

This is currently a common design system because it gives a lot more availability to build modular and bring directly on site and a reduced construction. Due to the design time required and scale of the proposed construction, this was not feasible for the proposed centre of excellence for construction.

One of the key advantages to this proposal would be the expansion/ future proofing it use, the internal design space would be adaptable given its box like structure to office spaces or even accomodation.

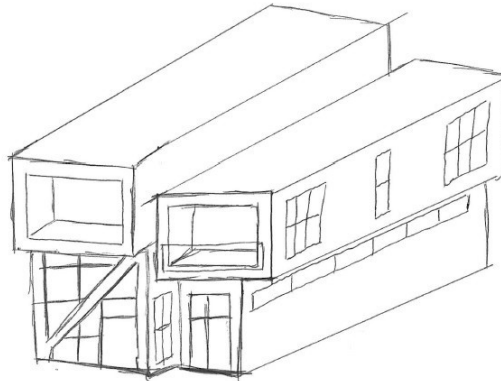


Image 10 – The Stacked Box's - Isometric View

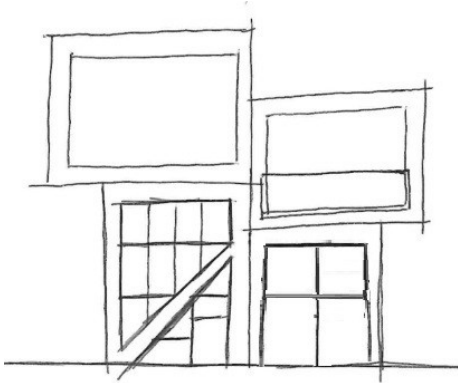


Image 11 – The Stacked Box's - Front View

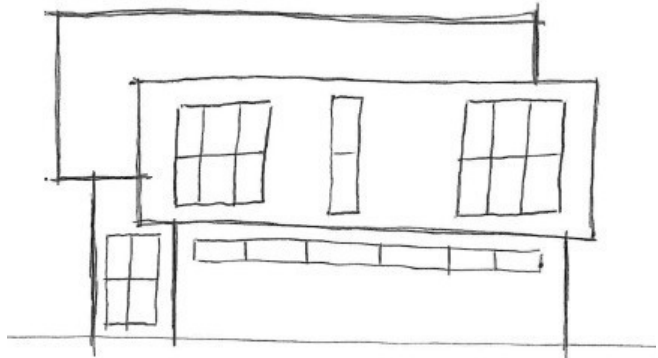


Image 12 – The Stacked Box's - Side View

The proposed design lacks a strong iconic presence and does not reference the local context or history of the surrounding area. As a result, it reads as a generic contemporary structure rather than a building that meaningfully engages with its setting or the public.

The distribution of natural light to the ground floor may be limited, without including skylights which may impact the visual aspect of the building.

Additionally, the elevated structural elements would require a more substantial foundation system to resist uplift forces and maintain stability. This would increase structural complexity and potentially raise construction costs.

6) Proposed Design Images



Image 13 - South-East Isometric View (OpenAI, 2026a)



Image 14 - South-East Exterior View (OpenAI, 2026b)



Image 15 - East Elevation (OpenAI, 2026c)



Image 16 - Meeting Rooms (OpenAI, 2026d)



Image 17 - Classroom 03 (OpenAI, 2026e)



Image 18 - Classroom 04 – IT Room (OpenAI, 2026f)

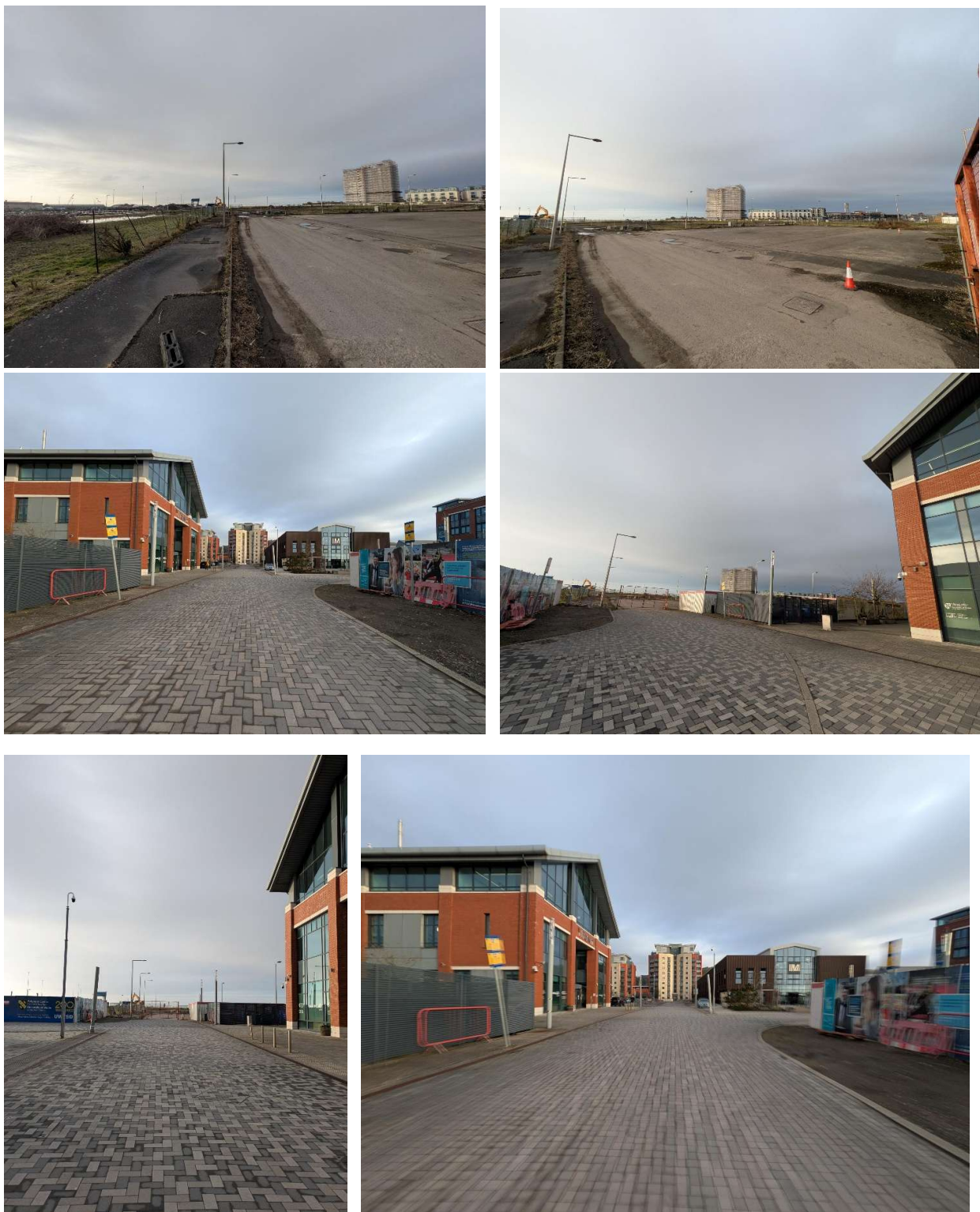


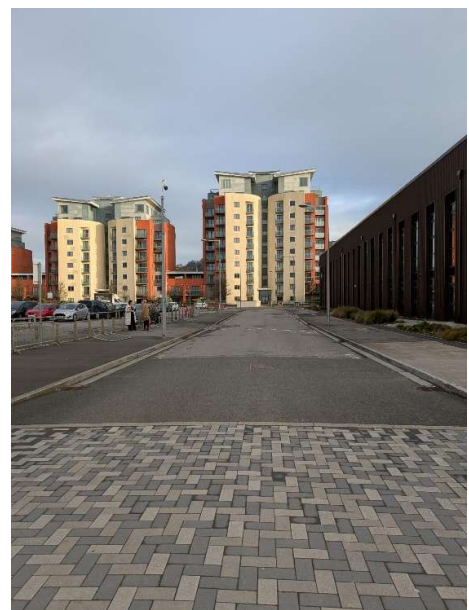
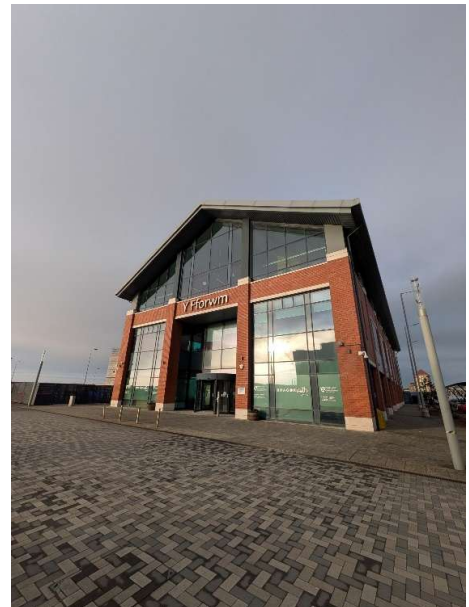
Image 19 - Entrance (OpenAI, 2026g)

7) References

- 1) Bluseal Insulated Rigid Door (2026). Insulated Rigid Door (online)]. Available at: <https://www.blusealdoors.co.uk/product/insulated-rigid-door/> (Accessed 3 Mar. 2026)
- 2) Kingspan Insulated Panels (2026). QuadCore Louvre Wall Panel (online). Available at: <https://www.kingspan.com/gb/en/products/insulated-panels/wall-panels/quadcore-louvre-wall-panel/?s=t> (Accessed 3 Mar. 2026)
- 3) OpenAI (2026a) *Rendered Image produced by Revit of South-East isometric view of the 'New Centre of Excellence for Construction Training'*. AI-generated image. Generated using ChatGPT
- 4) OpenAI (2026b) *Rendered Image produced by Revit of South-East exterior view of the 'New Centre of Excellence for Construction Training'*. AI-generated image. Generated using ChatGPT
- 5) OpenAI (2026c) *Rendered Image produced by Revit of East Elevation of the 'New Centre of Excellence for Construction Training'*. AI-generated image. Generated using ChatGPT
- 6) OpenAI (2026d) *Rendered Image produced by Revit of Meeting Rooms of the 'New Centre of Excellence for Construction Training'*. AI-generated image. Generated using ChatGPT
- 7) OpenAI (2026e) *Rendered Image produced by Revit of Classroom 03 of the 'New Centre of Excellence for Construction Training'*. AI-generated image. Generated using ChatGPT
- 8) OpenAI (2026f) *Rendered Image produced by Revit of Classroom 04 – IT Room of the 'New Centre of Excellence for Construction Training'*. AI-generated image. Generated using ChatGPT
- 9) OpenAI (2026g) *Rendered Image produced by Revit of the 'New Centre of Excellence for Construction Training' Entrance*. AI-generated image. Generated using ChatGPT
- 10) Prince of Wales Dock as at 1898. Swansea and Port Talbot Docks – Maps (online). Available at: <http://www.swanseadocks.co.uk/docksnewsite/maps.html> (Accessed 4 Mar. 2026)

8) Appendix 1 – Site Visit Images







Trinity Group Ltd

BIM Execution Plan

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**New Centre of Excellence
for Construction**

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Abbreviations

BIM	-	Building Information Modelling
BEP	-	BIM Execution Plan
LOD	-	Level of Development
COBie	-	Construction-Operations Building Information Exchange
EIR	-	Exchange Information Requirements
MDR	-	Master Document Register

1) Introduction

The following Building Information Modelling (BIM) Execution Plan is a structured framework highlighting the effective procedures for the implementation of BIM 3D model throughout a project's lifecycle. This document outlines the requirements of compliance to ensure minimum standards of consistency between all project team members.

The BIM execution plan is key to outline important information to all parties involved in the project, this includes key project information, the responsibilities of each discipline on specific task, expectations on data exchange and workflows ensuring all documentation is in relevant format. This established consistency throughout the project and align expectations and provides transparency between all stakeholders.

By complying the BIM execution plan, it ensures a smooth transition from the design phase through the construction phase & completion. Overall ensuring a high-quality, quick and decisive decision making, minimising unexpected risks during construction and a successful execution.

2) Project Information

The table below highlights key site information that should be included on all project deliverables / documentation:

Table 1 - Project Information Table

Project Name:	Centre of Excellence for Construction
Project Owner:	University of Wales Trinity Saint David
Project Number	001
Project Address / Location:	Adjacent to Y Fforwm, King's Road, SA1 Swansea Waterfront, Swansea, Wales, SA1 8EW.
Project Description:	Proposed development for a car park and a new centre of excellence for construction training. Development to include 2no. construction training area's for both modern & traditional buildings.
Project Brief and CDM Requirements	Proposal of Academic and Commercial spaces comprising of a Proposed Site Area = 4145m ² with a Building Floor Area= 1410m ²
Project Deliverables to BIM Level:	BIM Level 2
Client Name	ACE Capital projects LTD
Client Address	Kings Road, SA1
Contract Type / Delivery Method:	NEC4 Lump Sum (Option A)
Planned Project Completion Date	August 2027 (22 Month Duration)

3) Information Delivery Milestone

The dates below are estimate dates when key milestones are anticipated to be completed. Giving the project a basis on completion dates.

Table 2 – Information Delivery Milestone Dates Table

Project (RIBA) Stage	Milestone	BIM Data Level	Start Date	Completion Date
Stage 1	Preparation and Brief	-	-	01/10/2025
Stage 2	Concept Design	1	01/10/2025	10/12/2025
Stage 3	Developed Design	1	10/12/2025	16/03/2025
Stage 4	Technical Design	2	16/03/2025	13/05/2025
Stage 5	Construction	2	-	-
Stage 6	Handover	2	-	August 2027
Stage 7	Operations	-	Post August 2027	TBC

4) Roles and Responsibilities

4.1) Project Contacts

The below details are all parties that should be included in direct communication relevant to the role discussed. (e.g. All communication regarding procurement, include Quantity Surveyors withing the email recipient)

Table 3 - Project Contacts Table

Role	Contact Name	Contact Details
BIM Engineer	Timothy Mills	2206144@student.uwtsd.ac.uk
Civil Engineer	Nathan Morris	2015585@student.uwtsd.ac.uk
Environmental Engineer	Callum Jones	2306025@student.uwtsd.ac.uk
Quantity Surveyor	Jordan Jones	2114985@student.uwtsd.ac.uk
Quantity Surveyor	Evan Davies	2102939@student.uwtsd.ac.uk
Quantity Surveyor	Jac Beynon	2116579@student.uwtsd.ac.uk
Quantity Surveyor	Dafydd Allcock	2106960@student.uwtsd.ac.uk
Construction Manager	Joseph Murnane	2114075@student.uwtsd.ac.uk
Construction Manager	Sean Bamber	2320765@student.uwtsd.ac.uk

4.2) Project Roles & Authorities

Table 4 - BIM Roles Table

Code	BIM Role	Traditional Role	Activities	Authorities
Appointing Client Role				
CR	Client Information Manager	Technical Authority	Manages the project on behalf of the client and producing the projects EIR	Accepts and rejects documentation (Shared to published documentation)
PM	Client Project Manager	Project Manager	Clients Project Documentation Manager	Clients Project Documentation Manager
SC	Security Manager	Security Manager	Takes Ownership of the built asset security management plan/information requirements and security breach protocols.	Ownership of the project security information
Trinity Group Ltd BIM Appointed Roles				
PDM	Project Delivery Manager	Design Manager / Project Lead	Assure delivery information aligns with the client's delivery requirements.	Accepts and rejects documentation within the shared area.
LBC	Lead BIM Coordinator	-	Coordinates delivery of all design information. Manage information development and information review.	Accepts or rejects model information
DC	Document Controller	Document Controller	Controls the information received from the client and works with the PDM & LBC	Rejects information that does not comply with projects standards.
LD	Lead Designer	Lead Designer	Coordinated delivery of all design activities. Manages model review & information developments.	Confirm status and review information for use within the shared area.
TT	Tasked Team	Technologists	Undertake the relevant tasks that align to project specifications.	Reports to LD and LBC to align delivery expectations
CE	Civil Engineer	Engineer	Undertake the relevant civil and structural tasks that align to project specifications.	Reports to LD and LBC to align delivery expectations
EE	Environmental Engineer	Engineer	Undertake the relevant environmental tasks that align to project specifications.	Reports to LD and LBC to align delivery expectations
QS	Quantity Surveyor	Quantity Surveyor	Use the information provided from the BIM Model to analyse accurate costs based on project	Coordinates with the LD & PDM to align delivery expectations
CM	Construction Manager	Construction Manager	Use the BIM Model to provide accurate scheduling & construction phase plans	Coordinates with the LD and LBC & PM to align delivery expectations

5) Project Goals

The below table highlights the goals that are to be achieved by undertaking BIM techniques. Emphasising its priority to the overall project how BIM is used to achieve the individual goal.

Table 5 - Project Goals Table

Priority	Goal Description	BIM Uses
High	Production of accurate & site co-ordinated project plans to support construction	Drawing Extraction, Co-ordinated documentation, Construction Information.
High	Production of accurate material take offs to aid in detailed material costs	Cost estimation, material take-off, minimise wastage.
High	Multidisciplinary coordination to minimise design conflicts prior to construction.	Clash detection, coordination reviews, risk reduction
High	Support engineering analysis, allowing integration between BIM model (Autodesk Revit) and analytical tool (Autodesk Robot)	Structural Modelling, Analytical model aligns with BIM Model
Medium	Digital records through the project design phase, highlighting project decisions	Document control, change management, ISO Standard compliance
Medium	Improved collaboration and coordination between project stakeholders through shared digital models	Model sharing, multidisciplinary coordination & communication efficiency.
Medium	Enhance project visualisation to support client understanding and design decision making.	3D visualisation, walkthroughs, design reviews, stakeholder engagement.
Medium	Improve asset information for future operation and maintenance of the building after completion	Asset data management, COBie outputs, Facilities Management integration, digital handover.
Low	Construction planning to optimise site logistics ensuring safety during the project's construction.	Site Modelling, Construction planning, construction documentation.
Low	Support health and safety planning by identifying potential hazards during construction activities	Hazard visualisation, site risk planning, construction sequencing support.
Low	Improve communication with the public or non-technical stakeholders through visual presentations.	3D imagery, stakeholder presentations, public engagement models
Low	Use BIM to assist in prefabrication and off-site manufacturing where applicable	Model based fabrication sequence, component detailing, reduced site work.
Low	Provide a digital record model for reference during future refurbishment or extension works.	As-built modelling, record documentation, digital handover.

6) BIM Use & Responsible Parties

The Table Below identifies who is responsible for each task to be undertaken in the project.

Table 6 - BIM Uses & Responsibilities Table

Design Phase						
Task	Modelling Element Authority					
Existing Modelling	ARCH	CIV				
Proposed Steelwork	ARCH	STR				
Proposed Civil Elements	ARCH	CIV				
Proposed Electrical Elements	ARCH	ELE				
Proposed Mechanical Elements	ARCH	MEP				
Structural Analysis	STR					
Civil Analysis	CIV					
Mechanical Analysis	MEP					
Wind Flow Analysis	CIV	MEP				
Lighting and Energy Analysis	Elec					
Design/Model Reviews	ARCH	CIV	STR	MEP	CM	
Sustainability Evaluation	ARCH	CM	MEP			
Health Safety Review	ARCH	CIV	STR	MEP	CM	
Budget Cost Estimation	QS					
Planning & Building Control Documentation	ARCH	CIV	STR	MEP	CM	

7) Information Management

Below highlights the required software, version and document format that is expected to be used to ensure BIM collaboration between all stakeholders is effective.

Table 7 - Information Management Table

BIM Use	Responsible Parties	Software	File Format
3D Modelling	Architect BIM Engineer	Autodesk Revit	.rvt / .ifc / .step / .dwg
Point Cloud Data	Surveyor BIM Engineer	Autodesk Recap Autodesk Revit	.rcs / e57 / .las
Drawing Production	Architect BIM Engineer Civil Engineer Structural Engineer Mechanical Engineer	Autodesk Revit AutoCAD Adobe Acrobat	.rvt / .ifc / .step / .dwg .dwg .pdf
Civil & Structural Analysis	Civil Engineer Structural Engineer	Autodesk Robot Tekla Tedd's	.rtd / .dxf / .dwg / .ifc / .sat
Cost Estimating	Quantity Surveyor	Microsoft Excel Microsoft Project Adobe Acrobat	.xlsx .mpt .pdf
General Project Documentation	All	Microsoft Word Adobe Acrobat	.docx .pdf

8) BIM Coordination System

During the project setup the project is to be coordinated accordingly with the following information, failure to do so may result in miss alignment with the primary model. (Refer to Appendix A

Table 8 - Project BIM Coordination System Table

Project Datum:	Latitude: 51.616883	Longitude: -3.9273414
	Latitude: 51°37'01"N	Longitude: 003°55'38"W
Height Datum:	+7m (7000mm)	
Project Location:	Easting (X): 266659	Northing (Y): 192655
Grid Reference:	SS666926	
Model Orientation to North	Angle: 5.48°	

9) Project Units

The following project units are to be implemented in all documentation assigned to the Centre of Excellence for Construction project: -

Table 9 - Project Units Table

Measurement Type	Units	Decimal Places
Angle	Degree's (°)	1
Area	Meter Squared (m ²)	1
Currency	Pounds (£)	2
Cost Per Area	Punds Per Meter Squared (£/m ²)	2
Distance	Meters (m)	2
Length	Millimetres (mm)	0
Volume	Meters Cubed (m ³)	2

10) Project Standards

This project will comply with BS EN ISO 19650 and UK BIM Level 2, to ensure all information processes are followed, all standards identified in the project standards table are highlighted below.

Table 10 - Project Standards Table

Type	Standard
BIM Compliance	UK BIM Level 2
Structural Engineering	Eurocodes 1 & 3
Civil Engineering	Eurocodes
Document Numbering System	BS EN ISO 19650 standard
Health & Safety Standards	CDM Regulations 2015
Asset Information Handover	COBie UK 2012

11) BIM – File Naming Convention

All documents associated with the Centre of Excellence for Construction project shall follow the document naming convention to comply with BIM standard BS EN ISO 19650:

Project Number – Originator – Volume – Level – Document Type - Role – Number – Revision

11.1) Project Numbers

Table 11 - Project Numbers

Project Number	Project Name
P001	Centre of Excellence for Construction

11.2) Originator

Each company shall agree a code between three to six characters, this shall be used for the duration of the project.

Table 12 - Originator Codes

Originator Abbreviation	Originator Company Name
ACE	Ace Capital Projects Ltd
UOW	University of Wales Trinity Saint David
TRN	Trinity Group

11.3) Volume

Table 13 - Volume Codes

Code	Volume
V1	Centre of Excellence for Construction – Main Building
V2	Centre of Excellence for Construction – Access & Parking
V3	Y FForum
V4	Plot B
ZZ	Not Applicable

11.4) Level

Table 14 - Level Codes

Level Code	Level	Elevation
F1	Foundation Level	+4.9m
S1	Site Level	+5.2m
L0	Ground Floor	+5.5m
L1	First Floor	+9.5m
R1	Roof Level	+13.5
ZZ	Multiple Levels/Location	N/A
XX	No Level /Location Applicable	N/A

11.5) Document Type

Table 15 – Document Type Codes

Code	Description	Code	Description
AL	Acknowledgment Letter	MI	Minutes
AP	Application	MS	Method Statement
BQ	Bill of Quantities	PP	Presentation
CE	Compensation Event	PR	Programme
CM	Comments	PI	Project Manager Instruction
CO	Correspondence	QT	Quotation
CP	Cost Plan	RD	Room Data Sheet
CT	Contract	RI	Request for Information
DA	Design & Access Statement	RP	Report
DC	Discharge of Conditions	SA	Schedule of Accommodation
DR	Drawing	SB	Service Brief
EN	Early Warning Notice	SC	Structural Calculation
HS	Health and Safety	SN	Snagging List
IV	Invoice	SP	Specification
MD	Model	SU	Survey

11.6) Roles

Table 16 - Role Codes

Code	Role
A	Architect
B	Building Surveyor
C	Civil Engineer
D	Drainage, Highways Engineer
E	Electrical Engineer
F	Facilities Manager
G	Geographical and Land Surveyor
H	Heating and Ventilation Designer
I	Interior Designer
K	Client
L	Landscape Architect
M	Mechanical Engineer
P	Public Health Engineer
Q	Quantity Surveyor
S	Structural Engineer
T	Town and County Planner
W	Contractor
X	Subcontractor
Y	Specialist Designer
X	General (non-disciplinary)

11.7) Revision

Table 17 - Revision Numbering

Revision Numbering	Revision Description
I1 / I2 / I3	Issue for Information
R1 / R2 / R3	Issue for Pre-Construction
C1 / C2 / C3	Issue for Construction

X1	As Built
----	----------

11.9) Document Numbering

All document numbering should be requested by document control and assign accordingly with the clients Master Document Register (MDR)

11.8) Document Naming Convention Examples

Structural calculation report for construction of the Centre of Excellence for Construction project

P001-TRN-V1-ZZ-RP-S-001-C1

A Pre-construction cost plan of the external works of the Centre of Excellence for Construction project

P001-TRN-V2-S1-CP-Q-001-R1

12) Level of Detail Strategy

Level of Detail (LoD) provides the graphical complexity and geometric precision of 3D model elements, increasing in detail from concept to as-built stages.

The following table gives the level of detail required for each stage of the project life cycle: -

Table 18 - Level of Detail Table

Level of Detail	Information Description	Information Description
LoD 1	Provides an initial response to requirement. May not be to scale	Initial Information
LoD 2	Aligned with the brief. Scaled geometry but is not constraint.	Concept Information
LoD 3	Dimensionally correct and developed whilst aligning with the initial brief.	Co-ordinated Information
LoD 4	Dimensionally correct and co-ordinated – for design	Integrated Production Information
LoD 5	Accurate prior and during construction to align with all subcontractors' designs.	Installation Information
LoD 6	Accurate and aligns with all constructed elements	As-Construction Information

Refer to Appendix B for a representation from NBS of the Level of Detail including a visual representation, the description & purpose associated with each stage.

13) References

- 1) Christchurch City Council (2019) *Template for BIM Execution Plan (BEP)*. Version 0.2, October 2019. Christchurch: Christchurch City Council.
- 2) GridReferenceFinder.com (no date) *Grid Reference Finder*. Available at: https://gridreferencefinder.com/#gr=SS6665992655|266659_s__c__s_192655|1 (Accessed: 15 January 2026).
- 3) Swaddle, P. (2022) *Level of detail Lod and digital plans of Work, NBS*. Available at: <https://www.thenbs.com/knowledge/level-of-detail-lod-and-digital-plans-of-work> (Accessed: 04 February 2026).

14) Appendix A

Grid Reference

SS 66659 92655

Grid Reference (6 figure)
SS666926

X (Easting) , Y (Northing)
266659 , 192655

Latitude , Longitude (decimal)
51.616880 , -3.9273404

Latitude , Longitude (degs, mins, secs)
51°37'01"N , 003°55'38"W

What3Words :
assets.awake.moss

Address (near) :
UWTSD Swansea, Portland Street, Mount Pleasant. Castle. Swansea. Wales. SA1

Postcode (nearest) :
SA1 3BD

Maps For Point :
[Ordnance Survey](#) | [Google](#) | [Bing](#) | [Streetview](#)

Tools for Point :
[QR Code](#) | [Info](#) | [Zoom here](#)

Share :
[Link For Point](#)

15) Appendix B



LOD bandings					
	Code	Description/ requirement	Purpose	Fabric example	Services example
2	Concept design What is typical for concept stage?	Visual information to provide general principles of the design. Showing arrangement of system with their relationship to internal and external context, and key project criteria to suit client brief. General descriptions would be expected to communicate principles of materiality, scope, colour and context. Expect strategic coordination with other professions to show general principles of the design.	To provide a visual indication of proposals at a concept stage and support general spatial coordination, identifying key requirements such as access and maintenance zones for primary systems.		
3	Spatial coordination What is typical as the design develops?	Visual information to provide developed principles of the design to a greater level of detail. Developed coordination between all professions. Visual development showing coordination for general size and primary relationships between different elements of the construction. Can form a brief for a specialist subcontractor or fabricator to progress with their technical design, fabrication and installation. This would be expected to include critical dimensional coordination, performance requirements and qualities of finish.	To provide a visual representation of proposals at a Design Development stage and to allow greater spatial coordination, confirming brief for Technical Design stage.		
4	Technical design What is required for technical design?	Visual information to provide fixed principles of the design supporting procurement. Developed coordination between all professions. Visual representations showing coordination for general size and relationships between different elements of the construction. Dimensionally accurate graphical representation of system, indicating primary performance characteristics. Graphical information represented may alter, dependent on visual information to be produced, e.g. scope of work drawings, setting out, floor loading, etc. Typical installation details separately produced, linked to model element and adjacent constructions.	To provide a visual representation of proposals at a Technical Design stage supporting full spatial coordination.		
5	Construction What has been constructed?	Visual information to provide full information to support construction/ installation. Developed coordination between all professions. Visual representations showing final coordination for size and relationships between different elements of the construction. Dimensionally accurate graphical representation of system, indicating primary performance characteristics and sufficient information to support installation. Typical installation details separately produced, linked to model element and adjacent constructions.	To provide sufficient information for construction/ installation of the required products. To be updated during the construction process to reflect final decisions.		
6	Record A record of the final constructed built asset for FM/ owners	Visual information (such as record drawings) showing an as-built record of the final systems and products installed in the built asset, and any relevant references to associated information. Visual and geometric data may be acquired through surveys (e.g. laser scanning) of the final built asset.	Visual data that reflects final selections, including any changes made during construction. To provide future reference during the operation stage of a building's life cycle to aid with maintenance, product replacement and disassembly. This will include any verification that demonstrates final results, e.g. final survey results.		

NBS 2022

Image 1 - Level of Detail (Swaddle, P. 2022)

**Structural Calculations – P001-TRN-V1-ZZ-RP-S-001_I1**

Sheet No.

1 of 49

Client:

ACE Capital projects LTD

Date:

25/03/2026

Project:

Centre of Excellence for Construction

by:

TM - 2206144

Description:

Structural Calculations

Checked by:

NM

STRUCTURAL CALCULATION REPORT

ACE CAPITAL PROJECTS LTD

CENTRE OF EXCELLENCE FOR CONSTRUCTION

**DOCUMENT NO. P001-TRN-V1-ZZ-RP-S-001****Student Information:- Timothy Mills - 2206144**

Revision	Date of Issue	Description
I1	18/03/2026	Issue for Information

Name	Title	Task	Date
Timothy Mills - 2206144 (BSc - Part Time Degree)	Structural Engineer	Originator	25/03/2026
Nathan Morris (BSc - Part Time Degree)	Civil Engineer	Checker	XX/XX/XXXX
Callum Jones (BSc – Full Time Degree)	Environmental Engineer	Approver	XX/XX/XXXX

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	Description:	Structural Calculations	Checked by:	NM

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	Description:	Structural Calculations	Checked by:	NM

EXECUTIVE SUMMARY

Purpose of Calculation	The proposed development is a continuation of a regeneration project of the Swansea dock. The proposed assessment is required to ensure that the steel structure of the building is suitable.		
Method of Calculation	Hand calculations Microsoft Excel Tekla Tedds Autodesk Robot		
Source documents used	BS EN 1990:2002 BS EN 1991-1:2002 BS EN 1993-1:2005	Eurocode - Basis of structural design + UK National Annex Eurocode 1 - General Actions + UK National Annex Eurocode 3 – Design of Steel Structures	
Key parameters used	All proposed steel to be grade S355		
Health and Safety risks	Top 3 Designers Health and Safety Risks Use of crane during high winds Working from Height Interaction with the public, access through the university grounds.		
Associated Drawings	P001-TRN-V1-L0-DR-A-001-R1 - GROUND FLOOR - PLANS P001-TRN-V1-L1-DR-A-001-R1 - FIRST FLOOR - PLANS P001-TRN-V1-R1-DR-A-001-R1 - ROOF – PLANS P001-TRN-V1-ZZ-DR-A-001-R1 - ELEVATION VIEWS - NORTH & EAST P001-TRN-V1-ZZ-DR-A-002-R1 - ELEVATION VIEWS - SOUTH & WEST P001-TRN-V1-ZZ-DR-A-003-R1 - FLOOR LEVELS - ISOMETRIC VIEW P001-TRN-V1-ZZ-DR-A-004-R1 – STRUCTURAL LAYOUTS		

1. PROJECT OVERVIEW

The Trinity Group has been instructed by ACE Capital Projects LTD to conduct a structural assessment of a new “Centre of Excellence For Construction” as an expansion of the University of Wales Trinity Saint Davids campus.

Trinity Group have been requested to progress the project to the end of the design phase which will allow for construction, this including member sizes and connection details.

For the civil details please refer to the Civil Calculation Report.

Below shows the preliminary steel layout that was agreed during the feasibility stage as part of this assessment to identify the primary member sizes within this report.

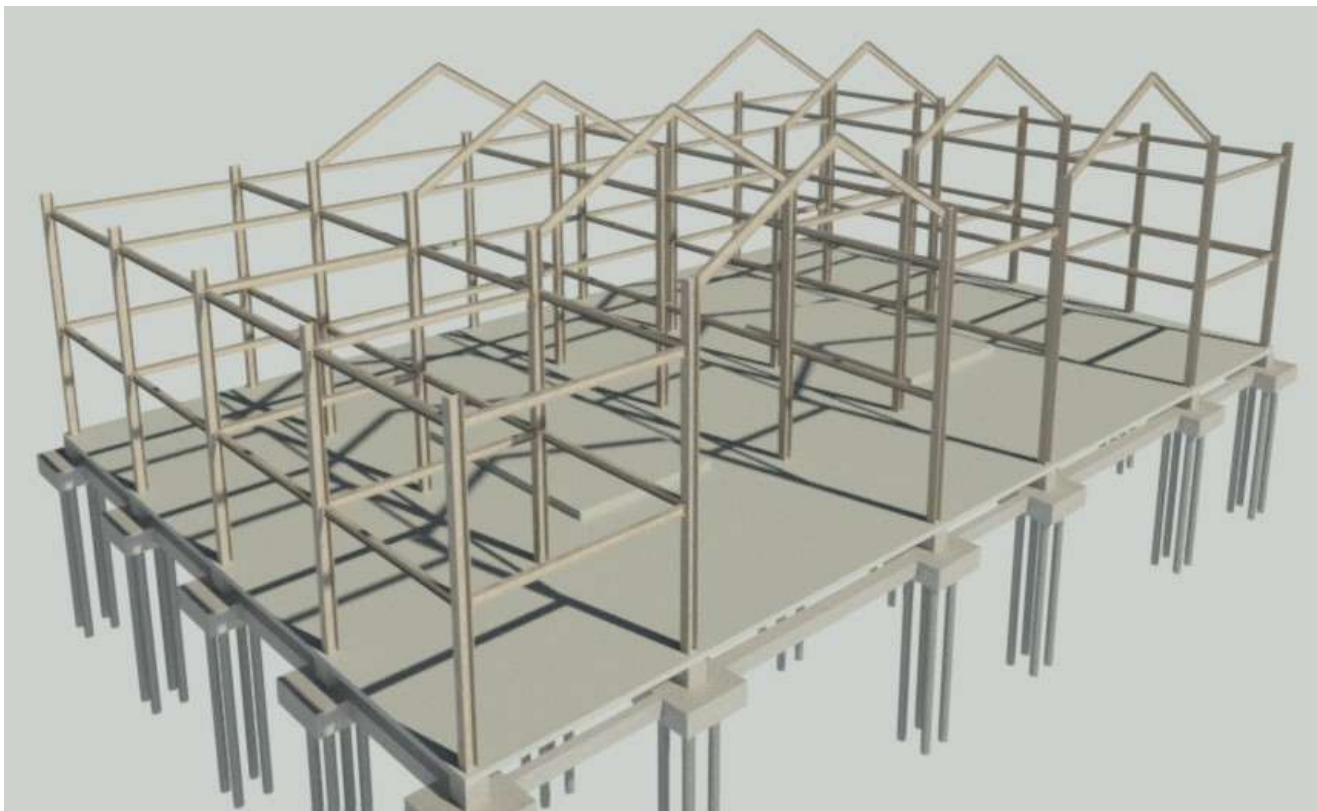


Image 1 - Isometric view of concept steelwork layout

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	Description:	Structural Calculations	Checked by:	NM

2. REFERENCES

2.1. CODES

The structural design will be carried out in accordance with the following standards which shall be current at the start of design. Other standards if applicable will be used as required.

BS EN 1990:2002 - Eurocode - Basis of structural design.

NA to BS EN 1990:2002 - National Annex for Eurocode 0 – Basis of structural design.

BS EN 1991-1-1:2002 - Eurocode 1 - Actions on Structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings.

NA to BS EN 1991-1-1:2002 - National Annex for Eurocode 1 - Actions on Structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings.

BS EN 1991-1-3:2003 - Eurocode 1 - Actions on Structures - Part 1-3: General actions – Snow loads.

NA to BS EN 1991-1-3:2003 - National Annex for Eurocode 1 - Actions on Structures - Part 1-3: General actions - Snow loads.

BS EN 1991-1-4:2005 - Eurocode 1 - Actions on Structures - Part 1-4: General actions – Wind actions.

NA to BS EN 1991-1-4:2005+A1:2010 - National Annex for Eurocode 1 - Actions on Structures - Part 1-4: General actions - Wind actions.

2.2. DESIGN DOCUMENTS

The following design documents have been developed as part of the scope for this project:

Table 1 - Design Document List

Document Number	Title
P001-TRN-V1-L0-DR-A-001-R1	GROUND FLOOR - PLANS
P001-TRN-V1-L1-DR-A-001-R1	FIRST FLOOR - PLANS
P001-TRN-V1-R1-DR-A-001-R1	ROOF - PLANS
P001-TRN-V1-ZZ-DR-A-001-R1	ELEVATION VIEWS - NORTH & EAST
P001-TRN-V1-ZZ-DR-A-002-R1	ELEVATION VIEWS - SOUTH & WEST
P001-TRN-V1-ZZ-DR-A-003-R1	FLOOR LEVELS - ISOMETRIC VIEW
P001-TRN-V1-ZZ-DR-A-004-R1	STRUCTURAL LAYOUTS

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	Project:	Centre of Excellence for Construction	by:	TM - 2206144
	Description:	Structural Calculations	Checked by:	NM

3. DESIGN PRINCIPLES

3.1. APPROACH TO DESIGN

The structure will be designed to ensure that it is adequate in its permanent condition, and considers site constraints, buildability, maintainability and decommissioning. The structure will sustain all actions and influences likely to occur during execution and use and meet the specified serviceability requirements for the structure.

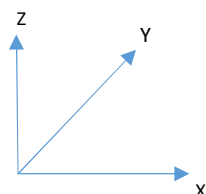
The design working life of new structures will be 50 years, unless stated otherwise.

Designs will be assessed for the following limit state conditions; ULS = Ultimate Limit State and SLS = Service Limit State. Actions used in the design will comprise of; Permanent Actions, Variable Actions, and where applicable Accidental Actions, and Geotechnical Actions.

3.2. GLOBAL AND LOCAL COORDINATE SYSTEM

The coordinate system outlined in this report is dependent on the software chosen. In any given area, the origin (X,Y,Z = 0,0,0) is defined as being the South West corner of the structural model for the given area. This is based on plant North. SCIA / Robot adopts the following axis convention:

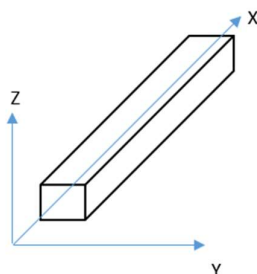
Global:



Where:

X = East
Y = North
Z = Vertical

Local:



Where:

X = along the axis of the member
Y = perpendicular to the length of the member
Z = perpendicular to the XY plane – vertical axis

3.3. UNITS AND MATERIALS

The following units of measurements and material weights are adopted:

Measurement	Unit
Length	m
Area	m ²
Force	N or kN
Moment	kNm
Mass	kg or ton
Pressure	kN/m ² (kPa) or N/mm ² (MPa)
Density	kg/m ³ or kN/m ³
Temperature	°C
Acceleration Gravity	$g = 9.81 \text{ m/s}^2$ (rounded to 10 m/s^2)

Material	Weights
Plain Concrete	24 kN/m ³
Reinforced Concrete	25 kN/m ³
Steel	78.5 kN/m ³
Water	10 kN/m ³
Soil	Specified in geotechnical data, varying with depth

3.4. METHODS OF CALCULATION

All analysis will be undertaken through the Tekla Tedds Software.

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	Description:	Structural Calculations	Checked by:	NM

4. STRUCTURE

4.1. STRUCTURE OVERVIEW

The proposed structure is built up of 2 main warehouse area's which required full clearance from ground floor level to underside of roof beams, this restricts the analysis basis, connections for the pitch roof beams will have to be fixed (haunch detail).

The basis for the analysis will be to undertake the loadings on the worst affected area of the building, and all members will adopt the sizing, this simplifying the manufacturing stage with repetitive detailing and repetitive member type.



Image 2 - South-East Isometric View (OpenAI, 2026a)

Connection design has not been considered; this is to be completed by the approved appointed contractor for the fabrication.

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	Description:	Structural Calculations	Checked by:	NM

4.2. WIND DESIGN LOAD (W)



Project	New Centre of Excellence for Construction	Name	Date	
Project No.	P001	By	TM	07/03/2026
Client Project No.	N/A	Chk'd	CJ	XX/XX/XX
Document No.	P001-TRN-ZZ-SA-RP-X-001	App'd	NM	XX/XX/XX
Calculation Title	Wind Load Calculation	Sheet	1	of 4

Reference	Calculation	Output
	vb,map = 23.2 m/s From map basic wind velocity (see page 2) A = 7 m Altitude Calt = 1.007 (for z<=10, conservative approach to use this for all building heights) vb,0 = 23.36 m/s Cdir = 1.0 (1 for conservative approach) Cseason = 1.0 (1 for conservative approach) Cprob = 1.0 (1 for conservative approach) vb = 23.36 m/s Basic wind velocity qb = 0.33 kN/m² Basic wind pressure Determine z - hdis If the site is not in a town, or for a conservative approach, take hdis = 0 hdis = 0 m z = 9.5 m Height of building or height at which peak wind pressure required Dist to shoreline = 0.06 km From Map (see page 3) Ce(z) = 2.7 From Graph (see page 4) qp(z) = 0.90 kN/m² Peak wind pressure for design (SLS) at height z Above assumes that orogrphay is not significant. vp(z) = 38.39 m/s Wind speed that corresponds to the peak wind pressure at height z	

Client: ACE Capital projects LTD

Date:

25/03/2026

Project: Centre of Excellence for Construction

by:

TM - 2206144

Description: Structural Calculations

Checked by:

NM

Project	New Centre of Excellence for Construction	Name	TM	Date	07/03/2026
InSite Project No.	P001	By	TM		
Client Project No.	N/A	Chk'd	CJ		XX/XX/XX
Document No.	P001-TRN-ZZ-SA-RP-X-001	App'd	NM		XX/XX/XX
Calculation Title	Wind Load Calculation	Sheet	2	of	4

Reference	Calculation	Output
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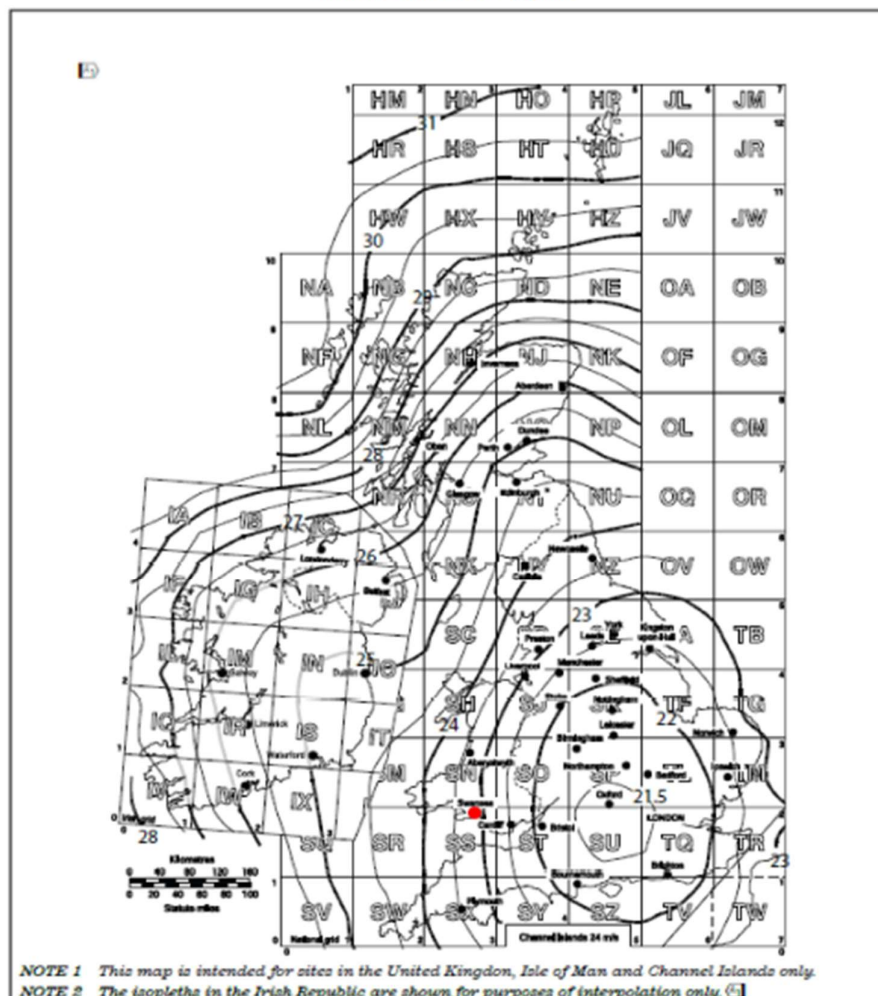
Basic Wind Velocity Map

● Location of site

$v_{b,map} = 23.2 \text{ m/s}$

NA to BS EN 1991-1-4:2005+A1:2010

Figure NA.1 Value of fundamental basic wind velocity $v_{b,map}$ (m/s) before the altitude correction is applied





Structural Calculations – P001-TRN-V1-ZZ-RP-S-001_I1

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Project: Centre of Excellence for Construction

by:

TM - 2206144

Description: Structural Calculations

Checked by:

NM

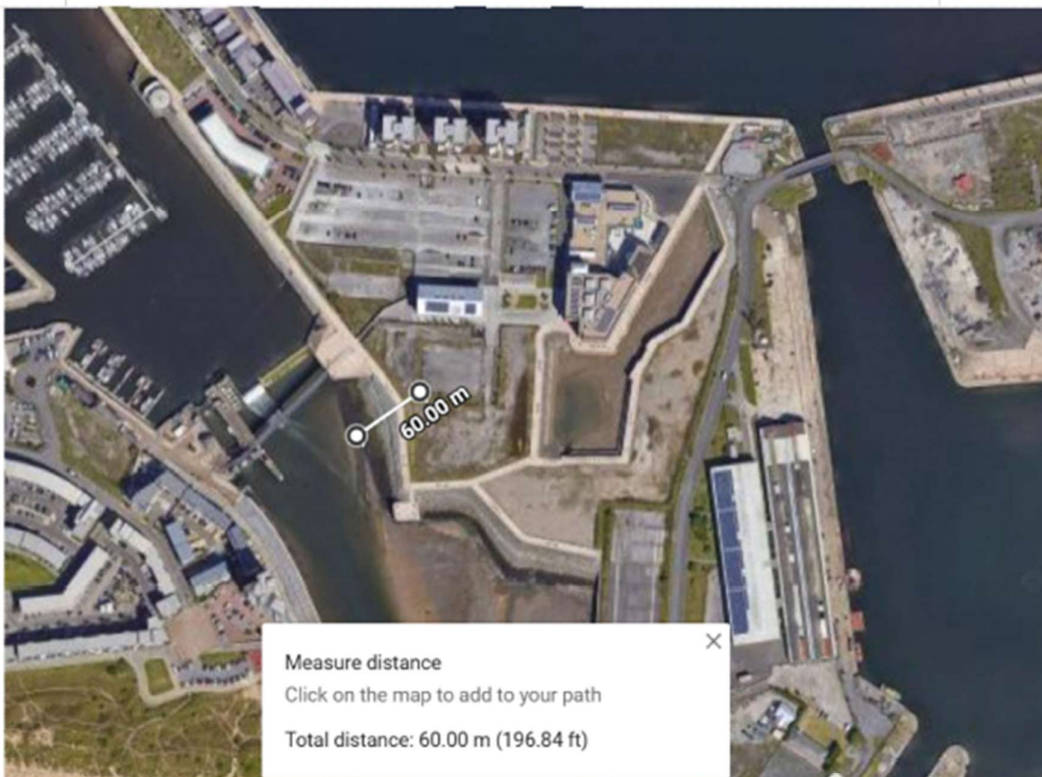


Project	New Centre of Excellence for Construction	Name	TM	Date	07/03/2026
InSite Project No.	P001	By	TM		
Client Project No.	N/A	Chk'd	CJ		XX/XX/XX
Document No.	P001-TRN-ZZ-SA-RP-X-001	App'd	NM		XX/XX/XX
Calculation Title	Wind Load Calculation	Sheet	3	of	4

Reference	Calculation	Output
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Distance to Shoreline

Dist to shoreline = 0.06 km



Client: ACE Capital projects LTD

Date:

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Project: Centre of Excellence for Construction

by:

TM - 2206144

Description: Structural Calculations

Checked by:

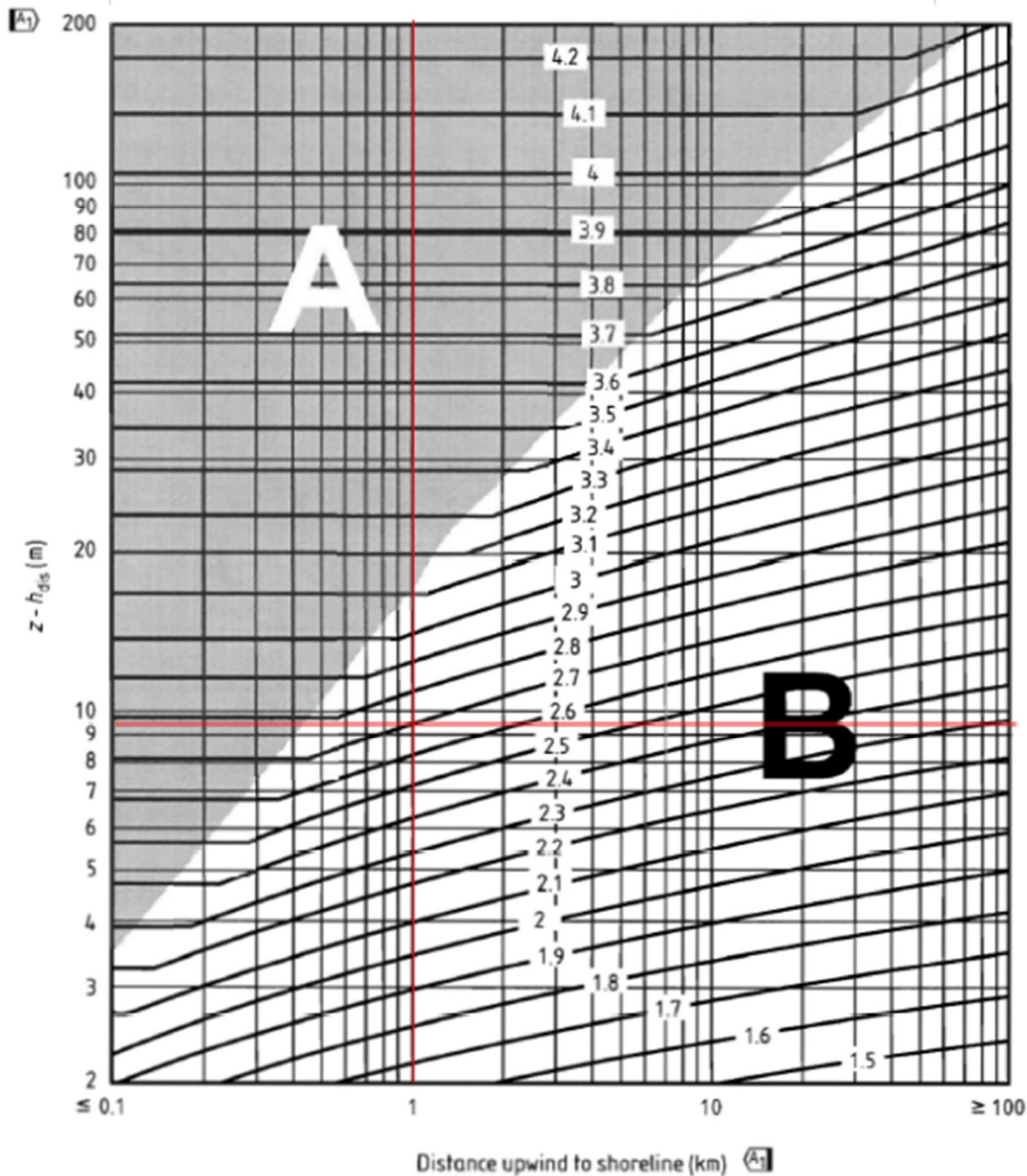
NM

Project	New Centre of Excellence for Construction	Name	TM	Date	07/03/2026
InSite Project No.	P001	By	TM		
Client Project No.	N/A	Chk'd	CJ		XX/XX/XX
Document No.	P001-TRN-ZZ-SA-RP-X-001	App'd	NM		XX/XX/XX
Calculation Title	Wind Load Calculation	Sheet	4	of	4

Reference	Calculation	Output
-----------	-------------	--------

Ce(z) Graph

$C_e(z) = 2.7$



Client: ACE Capital projects LTD

Date:

25/03/2026

Project: Centre of Excellence for Construction

by:

TM - 2206144

Description: Structural Calculations

Checked by:

NM

4.3. SNOW DESIGN LOAD (S)

	Project	Greenvolt - Suttieside Foundations for Skids		Name	Date	
	Project No.	P001		By	TM	07/03/2026
	Client Project No.	N/A		Chk'd	CJ	XX/XX/XX
	Document No.	P001-TRN-ZZ-SA-RP-X-001		App'd	NM	XX/XX/XX
	Calculation Title	Snow Load Calculation		Sheet	1	of 2

Reference	Calculation		Output
Z	= 2	Zone number, from map (see page 2)	
A	= 7 m	Altitude	
S_k	= 0.22 kN/m ²	Characteristic ground snow load	
<u>Undrifted snow load on roofs</u>			
μ_i	= 0.8	Snow load shape coefficient (see Table 5.2 below)	
C_e	= 1.0	Exposure coefficient (recommended 1.0 for all topographies)	
C_t	= 1.0	Thermal coefficient (recommended 1.0 for all roofing materials)	
S_k	= 0.22 kN/m ²	Characteristic ground snow load	
s	= 0.18 kN/m²	Snow Load	

BS EN 1991-1-3:2003+A1:2015
EN 1991-1-3:2003+A1:2015 (E)

Table 5.2 Snow load shape coefficients

Angle of pitch of roof α	$0^\circ \leq \alpha \leq 30^\circ$	$30^\circ < \alpha < 60^\circ$	$\alpha \geq 60^\circ$
Monopitch Roofs $\mu_1(\alpha)$	$\mu_1(0^\circ) \geq 0.8$	$\mu_1(0^\circ) \frac{(60^\circ - \alpha)}{30^\circ}$	0,0
Pitched Roofs $\mu_2(\alpha)$	0,8	$0,8 \frac{(60^\circ - \alpha)}{30^\circ}$	0,0
Multi-span Roofs $\mu_3(\alpha)$	$0,8 + 0,8 \alpha/30$	1,6	--

NOTE: The National Annex may specify the value of $\mu_1(0^\circ)$. The recommended value is $\mu_1(0^\circ) = 0,8$. 

Client: ACE Capital projects LTD

Date:

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Project: Centre of Excellence for Construction

by:

TM - 2206144

Description: Structural Calculations

Checked by:

NM

Project	Greenvolt - Suttieside Foundations for Skids		Name	Date	
InSite Project No.	P001		By	TM	07/03/2026
Client Project No.	N/A		Chk'd	CJ	XX/XX/XX
Document No.	P001-TRN-ZZ-SA-RP-X-001		App'd	NM	XX/XX/XX
Calculation Title	Snow Load Calculation		Sheet	2	of 2

Reference	Calculation	Output
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Zone Number & Characteristic Ground Snow Load Map

● Location of site

Zone Number = 2

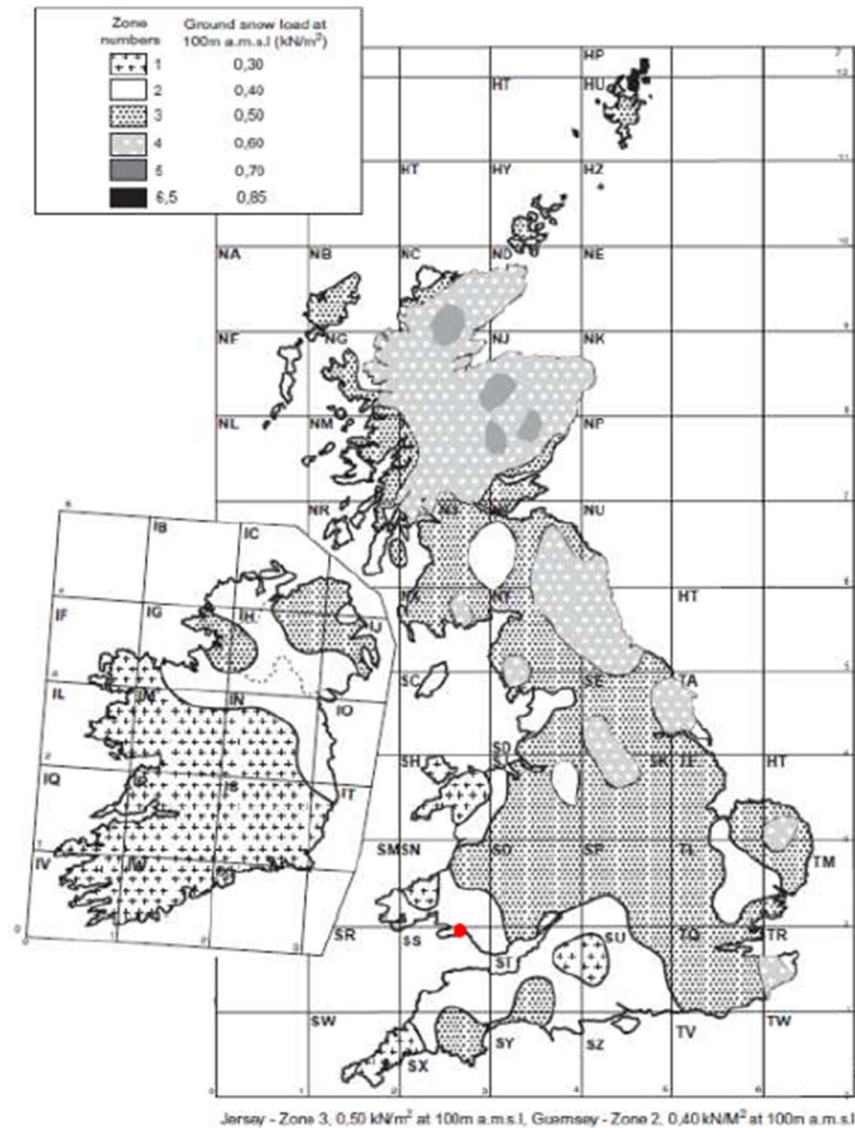


Figure NA.1 — Characteristic ground snow load map

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	Description:	Structural Calculations	Checked by:	NM

4.4. SEISMIC DESIGN LOAD (E)

The UK is classed as an area of very low seismicity. In accordance with UK National Annex to BS EN 1998-1 the provisions of Eurocode 8 are not to be applied.

Therefore, Seismic loading has not been considered in the structural design.

4.5. PERMANENT LOADS (G)

Permanent Load Applied to the Pitched Roof Members shown in the table below:-

The assumption has been made that 70% of the roof is covered in solar panels = Applied Permanent load to 3.92m of the roof beam with equal spacing between connection points.

Table 2 - Pitched Roof Members - Permanent Loads

Load Type	Design Value	Reference	Total Area Per Member	Load Applied
Roof Sheets	0.14 kN/m ²	Kingspan - QuadCore Louvre Wall Panel (Kingspan Limited, 2025)	33.6 m ²	0.84 kN/m
Solar Panels	0.12 kN/m ²	Maxeon - Performance 6 UPP, 530-555 W (Maxeon Solar Technologies, 2024)	23.5 m ²	0.72 kN/m
Services	0.15 kN/m ²	HVAC & Lighting Allowances	33.6 m ²	0.90 kN/m

Permanent Load Applied to the “Flat Roof – Intermediate Members” & “Flat Roof – Primary Members” are shown in the table below:-

For academic purpose, a design load of the green roof has been acquired from a standardised layout provided by a supplier’s information, this may not be like for like to the proposed design.

Table 3 - Flat Roof – Intermediate Members - Permanent Loads

Flat Roof - Intermediate Support Member 01				
Load Type	Design Value	Reference	Total Area Per Member	Load Applied to 6m Length
Green Roof Makeup - Saturated	1.19 kN/m ²	The Green Roof Company (The Green Roof Company, 2026)	19.5 m ²	3.87 kN/m
Rib deck flooring	0.12 kN/m ²	Tata Steel - ComFlor® 80 - 150mm Thick (Tata Steel UK, 2026)	19.5 m ²	0.39 kN/m
Concrete - Wet	2.63 kN/m ²	In Accordance with Ribdeck Datasheet (Tata Steel UK, 2026)	19.5 m ²	8.55 kN/m
Services	0.15 kN/m ²	HVAC, Mechanical & Lighting Allowances	19.5 m ²	0.49 kN/m

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	Description:	Structural Calculations	Checked by:	NM

Table 4 - Flat Roof – Primary Members Permanent Loads

Flat Roof - Primary Member			
Load Type	Design Value	Reference	Load Applied to 6.5m Length
Load transferred from intermediate supports	66.01 kN	In Accordance with Section 5.2 Structural Analysis	Point Load at Mid-Span

Permanent Load Applied to the “First-Floor Intermediate Support Member” & “First-Floor Primary Member” are shown in the table below:-

Table 5 - First Floor – Intermediate Members - Permanent Loads

First Floor - Intermediate Support Member 01				
Load Type	Design Value	Reference	Total Area Per Member	Load Applied to 6m Length
Concrete - Wet	2.63 kN/m ²	In Accordance with Ribdeck Datasheet (Tata Steel UK, 2026)	19.5 m ²	8.55 kN/m
Rib deck flooring	0.12 kN/m ²	Tata Steel - ComFlor® 80 - 150mm Thick (Tata Steel UK, 2026)	19.5 m ²	0.39 kN/m
Services	0.15 kN/m ²	HVAC, Mechanical & Lighting Allowances	19.5 m ²	0.49 kN/m

Table 6 - First Floor – Primary Members - Permanent Loads

First Floor - Primary Member			
Load Type	Design Value	Reference	Load Applied
Load transferred from intermediate supports	83.5 kN	In Accordance with Section 5.4 Structural Analysis	Point Load

Permanent Load Applied to the “Column” are shown in the table below:-

Table 7 - Column - Permanent Loads

Load Type	Design Value	Reference	Elevation of transferred load	Load Applied kN/m ²
Load transferred from Flat Roof - Primary Member	103.2 kN	Refer to Section 5.3 for Flat Roof - Primary Member	8m	-
½ Load transferred from Flat Roof – Intermediate Member – Outside member connecting to column	33.00 kN		8m	-
Load transferred from First Floor - Primary Member	130.4 kN	Refer to Section 5.5 for First Floor - Primary Member	4m	-

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½ Load transferred from First Floor – Intermediate Member – Outside member connecting to column	41.75 kN		4m	-
Wall Panels	0.13 kN/m ²	QuadCore Louvre Wall Panel (Kingspan, 2026)	Total Area = 4m x 8.5m + 1.5m x 2m	0.57 kN/m
Triple Glazed Windows	0.45 kN/m ²	Glazing Centre – Weight of Triple Glazed Unites (Glazing Centre, 2021)	Total Area = 2mx7m	0.75 kN/m

4.6. VARIABLE LOADS (Q)

All Variable loads have been calculated from the Structural Engineers Pocket Book Eurocodes, the table below shows the applied load to each element: -

Table 8 - Variable Loads

Load Type	Design Value	Page Reference
Pitched Roof Access	0.60 kN/m ²	Page 96 – Category H – Roofs not accessible except for normal maintenance and repair
Green Roof Access	0.60 kN/m ²	Page 96 – Category H – Roofs not accessible except for normal maintenance and repair
First Floor Access	3.00 kN/m ²	Page 94 – Category C31 – Corridors, Hallways, aisles in institutional type of buildings not subjected to crowds or wheeled vehicles, hostels, guest houses, residential clubs, and communal area in block of flats.
Wind	0.90 kN/m ²	Page 99 – Coastal Welsh Town – Maximum q for pc south westerly wind = 0.94 kN/m ² - Refer to Section 4.2 for accurate wind load calculation for SA1.
Snow	0.18 kN/m ²	Page 91 – Snow (Wet Compacted) – Unit Load = 0.60 kN/m ² - Refer to Section 4.3 for accurate wind load calculation for SA1.

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4.7. LOADING OVERVIEW

Table 9 - Loadings Overview Table

Load Type	Design Value	Applied to	Load Case
Self-Weight	Tekla Tedds	All members within the Software	LC1
Variable	See Section 4.6	Relevant members on the structure	LC2
Wind Load	0.90 kN/m ²	Structure area in each wind direction (S,E,W respectively)	LC3
Wind Load acting on Column Member	0.90 kN/m ²	Worse case load will be transferred on the whole column as a uniformly distributed load, if a more in-depth calculation was to be done a uniformly varying load would be applied to show the reduction of wind load that would be applied the closer to the ground level.	LC3
Snow Load	0.18 kN/m ²	Roof surface area	LC4
Services Load	0.15 kN/m ²	All area's subject to HVAC, Mechanical & Lighting services could be applied to. (Suspended supports	LC2
Pitched Roof – Permanent Loads	0.41 kN/m ²	5.2m member for 1 side of the pitched roof. Thus member supports an area of 6m x 5.2m.	LC1
Green Roof – Permanent Loads	4.09 kN/m ²	6m intermediate member which has a roof area of 3.25m x 6m acting on the member.	LC1
First Floor - Permanent Load	2.9 kN/m ²	6m intermediate member which has a floor area of 3.25m x 6m acting on the member.	LC1

Tekla Tedds software automatically runs linear combinations and envelopes for ULS and SLS load cases. Within each ULS/SLS combination, each load case has a coefficient applied to it. In each Analysis of Results section of every structure, the results show the load case combinations and coefficients which provide the worst-case stress/deflection/utilization.

Loading Area Applied to the Green Roof - Intermediate Members:-

For a 1-way spanning floor, the load transferred to the intermediate beam is half of the area between members as shown in the image below. The area each side of the member is 1.625m Width x 6m Length. The total area acting on the intermediate member is 3.25m x 6m = 19.5m²

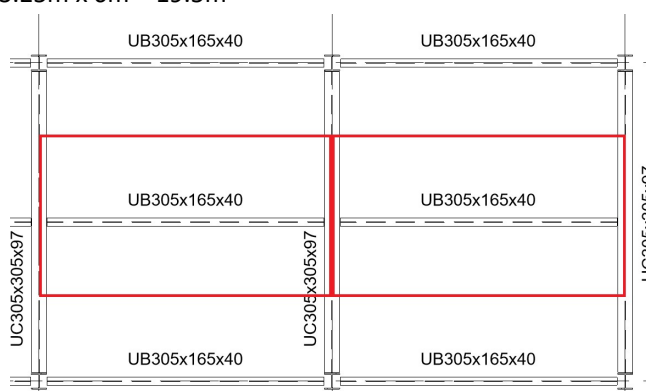


Image 3 - Green Roof - Intermediate Members - Loading Area

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Loading Area Applied to the Green Roof - Primary Members:-

Because the intermediate member connections have been designed as pinned connections, the intermediate member withstands all the moment imposed, the load transferred to the primary member is Shear only. The shear load is applied from both directions. This also causes a lateral restraint at the midspan of the member.

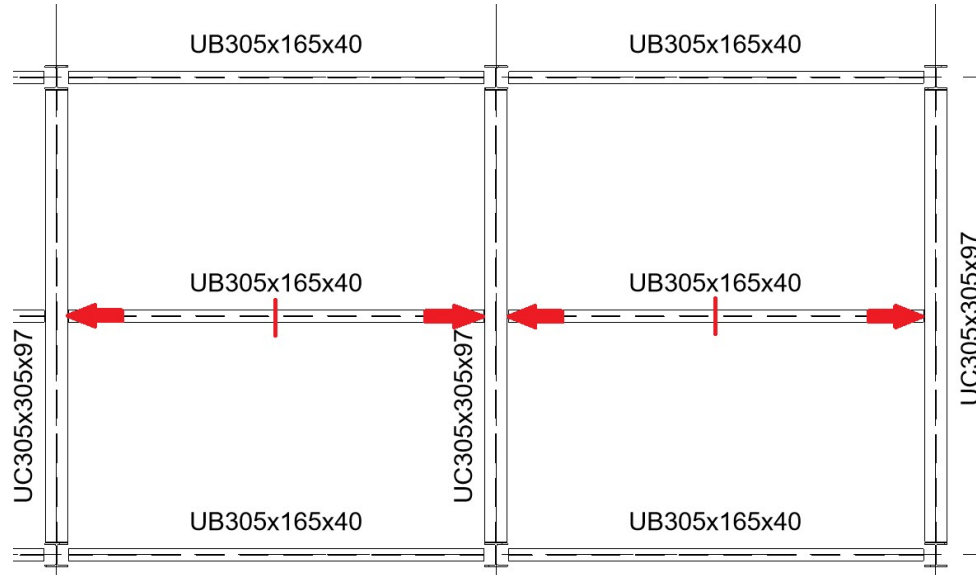


Image 4 - Green Roof - Primary Members - Loading

Loading Area Applied to the First Floor - Intermediate Members:-

Replicating the method used for the Green Roof – Intermediate Member. The area each side of the member is 1.625m Width x 6m Length. The total area acting on the intermediate member is 3.25m x 6m = 19.5m²

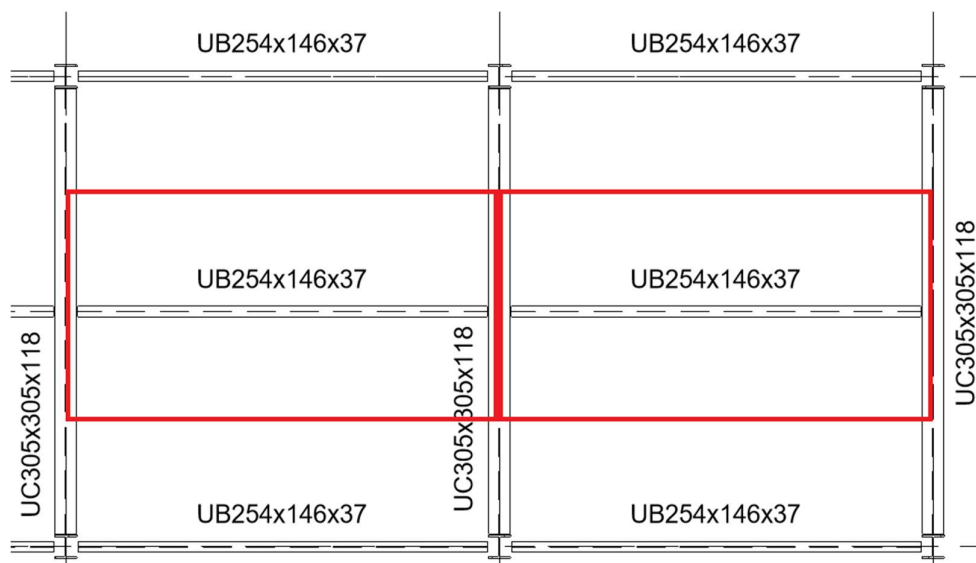


Image 5 - First Floor - Intermediate Members - Loading Area

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Loading Area Applied to the First Floor – Primary Members:-

Replicating the method used for the Green Roof – Primary Member, the shear load is applied from both directions. This also causes a lateral restraint at the midspan of the member.

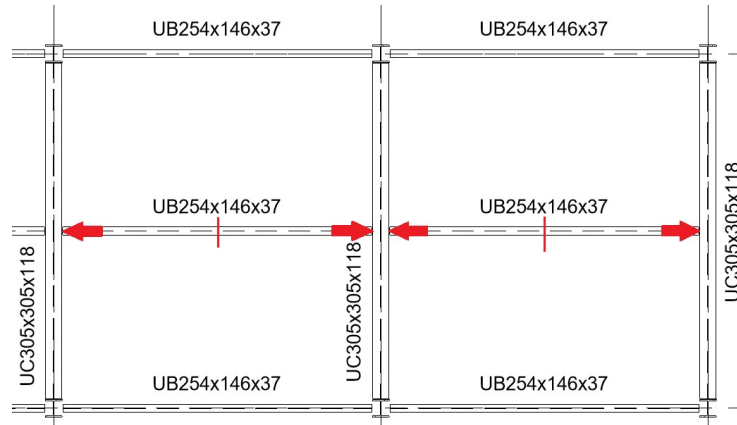


Image 6 - First Floor – Primary Members - Loading

Loading Area Applied to the Column Members:-

The arrangement shown in the below image occurs are both elevation +4m & +8m on the column.

The load from the primary member is transferred to the column, there are 2 outer members also acting on the member from the East and West side, the assumption is that the load from these members has been calculated as half of the Intermediate member given it is carrying half of the floor area.

Wind, wall panels and triple glazing has been calculated and applied as a continuous load across the column. To calculate the wind load accurately it should be broken down into 1m sections, and a uniformly varying load should be applied. The analysis has taken worst case loads.

Main consideration is the members connecting to the column could dictate the flange width required for connection purposes.

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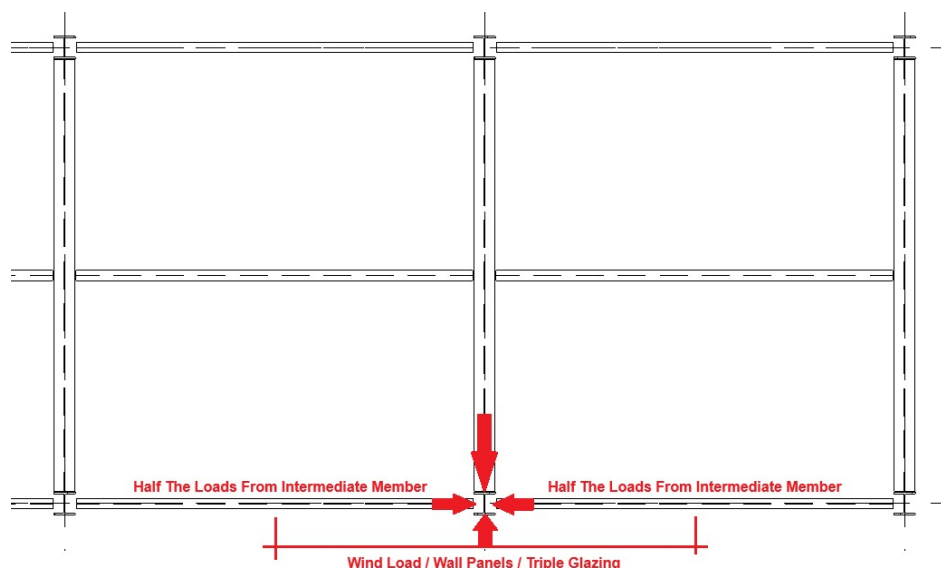


Image 7 - Column Members - Loadings

5. ANALYSIS AND RESULTS

The Analysis of the structure was undertaken using Tekla Tedds software. The output of the analysis has been presented in the table of results below. For the full analysis refer to the relevant section.

Table 10 - Table of Results for Pitched Roof Member – UB 254x146x31

Check Type	Design Value	Limit	Utilisation	Status
Shear Force	42.9 kN	335.5 kN	12.8 %	Pass
Bending Moment (y-y)	60.9 kNm	64.9 kNm	93.8 %	Pass
Deflection / Displacement	13.9 mm	13.9 mm	89.5 %	Pass

See Section 5.1 for full analysis

Table 11 - Table of Results for Flat Roof – Intermediate Member – UB 305x165x40

Check Type	Design Value	Limit	Utilisation	Status
Shear Force	83.5 kN	360.6 kN	23.2 %	Pass
Bending Moment (y-y)	125.3 kNm	152.0 kNm	82.5 %	Pass
Deflection / Displacement	14.2 mm	16.7 mm	84.9 %	Pass

See Section 5.2 for full analysis

Table 12 - Table of Results for Flat Roof – Primary Member – UC 305x305x97

Check Type	Design Value	Limit	Utilisation	Status
Shear Force	103.2 kN	790.1 kN	13.1 %	Pass
Bending Moment (y-y)	328.7 kNm	497.4 kNm	66.1 %	Pass
Deflection / Displacement	16.0 mm	18.1 mm	88.5 %	Pass

See Section 5.3 for full analysis


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Description: Structural Calculations

Checked by:

NM

Table 13 - Table of Results for First Floor – Intermediate Member – UB254x146x37

Check Type	Design Value	Limit	Utilisation	Status
Shear Force	66.0 kN	411.7 kN	16.0 %	Pass
Bending Moment (y-y)	99.0 kNm	107.0 kNm	92.5 %	Pass
Deflection / Displacement	2.4 mm	16.7 mm	14.4 %	Pass

See Section 5.4 for full analysis

Table 14 - Table of Results for First Floor – Primary Member – UB305x305x118

Check Type	Design Value	Limit	Utilisation	Status
Shear Force	130.4 kN	924.4 kN	14.1 %	Pass
Bending Moment (y-y)	415.4 kNm	682.0 kNm	60.9 %	Pass
Deflection / Displacement	16.3 mm	18.1 mm	90.2 %	Pass

See Section 5.5 for full analysis

Table 15 - Table of Results for Column Members – UB305x305x129

Check Type	Design Value	Limit	Utilisation	Status
Shear Resistance (y-y)	252.9 kN	1008.5 kN	25.1 %	Pass
Bending Resistance (y-y)	427.2 kNm	753.4 kNm	56.7 %	Pass
Compression Resistance	344.4 kN	3793.1 kN	9.1 %	Pass
Tension Resistance	165.9 kN	5747.4 kN	2.9 %	Pass
Deflection	21.9 mm	23.6 mm	2.9 %	Pass

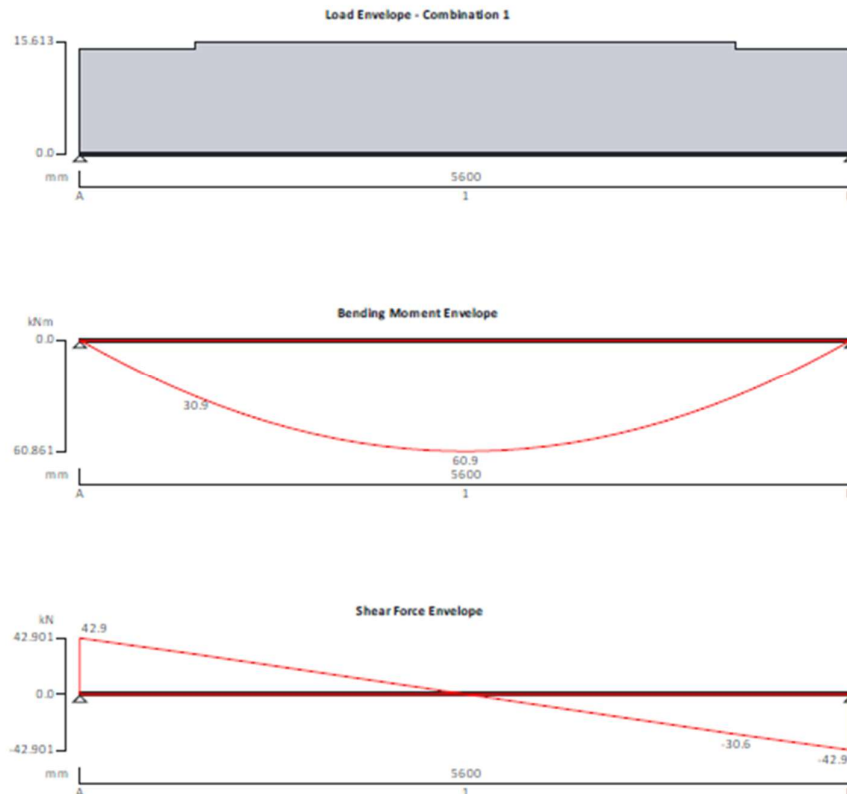
See Section 5.6 for full analysis

5.1. PITCHED ROOF MEMBER ANALYSIS

STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14



Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Applied loading

Beam loads

Permanent self weight of beam $\times 1$

Span 1 loads

Structural Engineers Handbook - Page 96 - Category H - Variable UDL

3.6 kN/m from 0 mm to 5600 mm

Snow Load for SA1 - Snow UDL 1.08 kN/m from 0 mm to 5600 mm

Wind Load for SA1 - Wind UDL 5.4 kN/m from 0 mm to 5600 mm

Roof Sheets - Permanent UDL 0.84 kN/m from 0 mm to 5600 mm

Services - Permanent UDL 0.9 kN/m from 0 mm to 5600 mm

Solar Panels - Permanent UDL 0.72 kN/m from 840 mm to 4760 mm

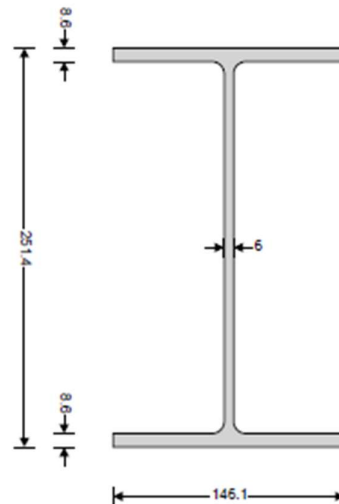
Load combinations

Load combination 1

Support A

Permanent $\times 1.35$

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	Project:	Centre of Excellence for Construction	by:	TM - 2206144
	Description:	Structural Calculations	Checked by:	NM
Variable × 1.50 Wind × 1.00 Snow × 1.00 Permanent × 1.35 Variable × 1.50 Wind × 1.00 Snow × 1.00 Permanent × 1.35 Variable × 1.50 Wind × 1.00 Snow × 1.00 Support B Permanent × 1.35 Variable × 1.50 Wind × 1.00 Snow × 1.00				
Analysis results Maximum moment $M_{max} = 60.9 \text{ kNm}$ $M_{min} = 0 \text{ kNm}$ Maximum shear $V_{max} = 42.9 \text{ kN}$ $V_{min} = -42.9 \text{ kN}$ Deflection $\delta_{max} = 13.9 \text{ mm}$ $\delta_{min} = 0 \text{ mm}$ Maximum reaction at support A $R_{A_{max}} = 42.9 \text{ kN}$ $R_{A_{min}} = 42.9 \text{ kN}$ Unfactored permanent load reaction at support A $R_{A_{Permanent}} = 7.1 \text{ kN}$ Unfactored variable load reaction at support A $R_{A_{Variable}} = 10.1 \text{ kN}$ Unfactored wind load reaction at support A $R_{A_{Wind}} = 15.1 \text{ kN}$ Unfactored snow load reaction at support A $R_{A_{Snow}} = 3 \text{ kN}$ Maximum reaction at support B $R_{B_{max}} = 42.9 \text{ kN}$ $R_{B_{min}} = 42.9 \text{ kN}$ Unfactored permanent load reaction at support B $R_{B_{Permanent}} = 7.1 \text{ kN}$ Unfactored variable load reaction at support B $R_{B_{Variable}} = 10.1 \text{ kN}$ Unfactored wind load reaction at support B $R_{B_{Wind}} = 15.1 \text{ kN}$ Unfactored snow load reaction at support B $R_{B_{Snow}} = 3 \text{ kN}$				
Section details Section type UKB 254x146x31 (Tata Steel Advance) Steel grade S355 EN 10025-2:2004 - Hot rolled products of structural steels Nominal thickness of element $t = \max(t_r, t_w) = 8.6 \text{ mm}$ Nominal yield strength $f_y = 355 \text{ N/mm}^2$ Nominal ultimate tensile strength $f_u = 470 \text{ N/mm}^2$ Modulus of elasticity $E = 210000 \text{ N/mm}^2$				



Partial factors - Section 6.1

Resistance of cross-sections

$$\gamma_{M0} = 1.00$$

Resistance of members to instability

$$\gamma_{M1} = 1.00$$

Resistance of tensile members to fracture

$$\gamma_{M2} = 1.10$$

Lateral restraint

Span 1 has lateral restraint at supports only

Effective length factors

Effective length factor in major axis

$$K_y = 1.000$$

Effective length factor in minor axis

$$K_z = 1.000$$

Effective length factor for torsion

$$K_{LT,A} = 1.000$$

$$K_{LT,B} = 1.000$$

Classification of cross sections - Section 5.5

$$\varepsilon = \sqrt{235 \text{ N/mm}^2 / f_y} = 0.81$$

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section

$$c = d = 219 \text{ mm}$$

$$c / t_w = 44.9 \times \varepsilon \leq 72 \times \varepsilon$$

Class 1

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section

$$c = (b - t_w - 2 \times r) / 2 = 62.5 \text{ mm}$$

$$c / t_f = 8.9 \times \varepsilon \leq 9 \times \varepsilon$$

Class 1

Section is class 1

Check shear - Section 6.2.6

Height of web

$$h_w = h - 2 \times t_f = 234.2 \text{ mm}$$

Shear area factor

$$\eta = 1.000$$

$$h_w / t_w < 72 \times \varepsilon / \eta$$

Shear buckling resistance can be ignored

Design shear force

$$V_{Ed} = \max(\text{abs}(V_{\max}), \text{abs}(V_{\min})) = 42.9 \text{ kN}$$

Shear area - cl 6.2.6(3)

$$A_v = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 1637 \text{ mm}^2$$

Design shear resistance - cl 6.2.6(2)

$$V_{c,Rd} = V_{pl,Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{M0} = 335.5 \text{ kN}$$

PASS - Design shear resistance exceeds design shear force

Client: ACE Capital projects LTD

Date:

25/03/2026

Project: Centre of Excellence for Construction

by:

TM - 2206144

Description: Structural Calculations

Checked by:

NM

Check bending moment major (y-y) axis - Section 6.2.5

Design bending moment

$$M_{Ed} = \max(\text{abs}(M_{s1_max}), \text{abs}(M_{s1_min})) = 60.9 \text{ kNm}$$

Design bending resistance moment - eq 6.13

$$M_{b,Rd} = M_{p,Rd} = W_{ply} \times f_y / \gamma_{M0} = 139.5 \text{ kNm}$$

Slenderness ratio for lateral torsional buckling

Correction factor - Table 6.6

$$k_c = 0.94$$

$$C_1 = 1 / k_c^2 = 1.132$$

Curvature factor

$$g = \sqrt{1 - (I_z / I_y)} = 0.948$$

Poissons ratio

$$\nu = 0.3$$

Shear modulus

$$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$$

Unrestrained length

$$L = 1.0 \times L_{s1} = 5600 \text{ mm}$$

Elastic critical buckling moment

$$M_{cr} = C_1 \times \pi^2 \times E \times I_z / (L^2 \times g) \times \sqrt{[I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z)]} = 68.9 \text{ kNm}$$

Slenderness ratio for lateral torsional buckling

$$\bar{\lambda}_{LT} = \sqrt{(W_{ply} \times f_y / M_{cr})} = 1.423$$

Limiting slenderness ratio

$$\bar{\lambda}_{LT,0} = 0.4$$

$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored

Design resistance for buckling - Section 6.3.2.1

Buckling curve - Table 6.5

$$b$$

Imperfection factor - Table 6.3

$$\alpha_{LT} = 0.34$$

Correction factor for rolled sections

$$\beta = 0.75$$

LTB reduction determination factor

$$\phi_{LT} = 0.5 \times [1 + \alpha_{LT} \times (\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta \times \bar{\lambda}_{LT}^2] = 1.433$$

LTB reduction factor - eq 6.57

$$\chi_{LT} = \min(1 / [\phi_{LT} + \sqrt{(\phi_{LT}^2 - \beta \times \bar{\lambda}_{LT}^2)}], 1, 1 / \bar{\lambda}_{LT}^2) = 0.462$$

Modification factor

$$f = \min(1 - 0.5 \times (1 - k_c) \times [1 - 2 \times (\bar{\lambda}_{LT} - 0.8)^2], 1) = 0.993$$

Modified LTB reduction factor - eq 6.58

$$\chi_{LT,mod} = \min(\chi_{LT} / f, 1) = 0.465$$

Design buckling resistance moment - eq 6.55

$$M_{b,Rd} = \chi_{LT,mod} \times W_{ply} \times f_y / \gamma_{M1} = 64.9 \text{ kNm}$$

PASS - Design buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to variable, wind and snow loads

Limiting deflection

$$\delta_{lim} = L_{s1} / 360 = 15.6 \text{ mm}$$

Maximum deflection span 1

$$\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min})) = 13.927 \text{ mm}$$

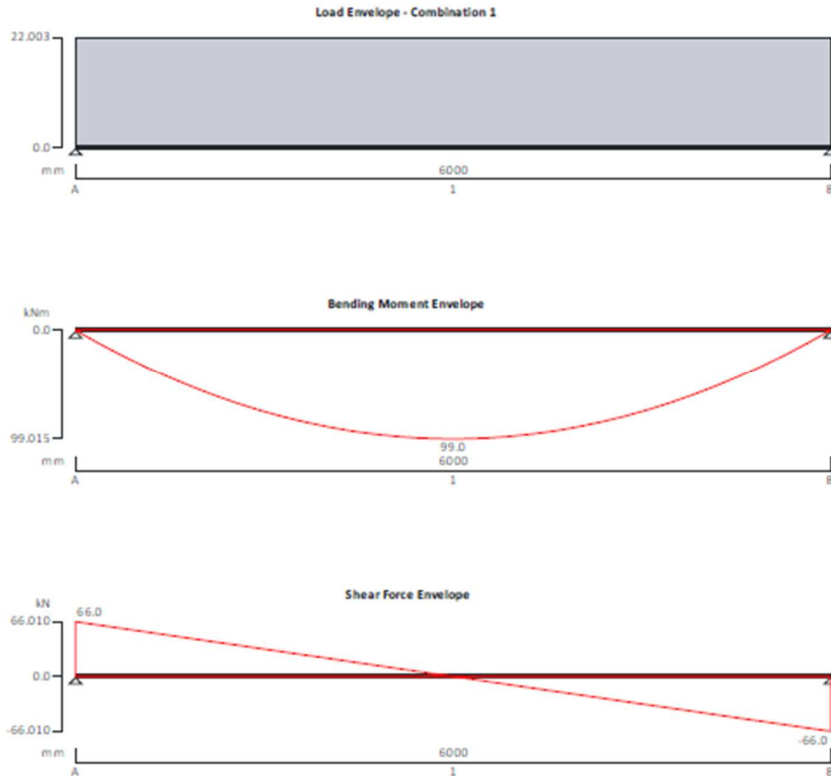
PASS - Maximum deflection does not exceed deflection limit

5.2. FLAT ROOF - INTERMEDIATE MEMBER ANALYSIS

STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14



Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Applied loading

Beam loads

Permanent self weight of beam $\times 1$

Span 1 loads

Structural Engineers Handbook - Page 96 - Category H - Variable UDL
1.95 kN/m from 0 mm to 6000 mm

Green Roof Makeup - Permanent UDL 3.87 kN/m from 0 mm to 6000 mm

Ribdeck Flooring - Permanent UDL 0.39 kN/m from 0 mm to 6000 mm

Concrete (WET) - Permanent UDL 8.55 kN/m from 0 mm to 6000 mm

Services - Permanent UDL 0.49 kN/m from 0 mm to 6000 mm

Snow Load for SA1 - Snow UDL 0.59 kN/m from 0 mm to 6000 mm

Load combinations

Load combination 1

Support A

Permanent $\times 1.35$

Variable $\times 1.50$

Snow $\times 1.00$

Permanent $\times 1.35$

Variable $\times 1.50$

Snow $\times 1.00$

Permanent $\times 1.35$

Variable $\times 1.50$

Snow $\times 1.00$

Support B

Analysis results

Maximum moment

$M_{max} = 99 \text{ kNm}$

$M_{min} = 0 \text{ kNm}$

Maximum shear

$V_{max} = 66 \text{ kN}$

$V_{min} = -66 \text{ kN}$

Deflection

$\delta_{max} = 2.4 \text{ mm}$

$\delta_{min} = 0 \text{ mm}$

Maximum reaction at support A

$R_{A_{max}} = 66 \text{ kN}$

$R_{A_{min}} = 66 \text{ kN}$

Unfactored permanent load reaction at support A

$R_{A_{Permanent}} = 41.1 \text{ kN}$

Unfactored variable load reaction at support A

$R_{A_{Variable}} = 5.9 \text{ kN}$

Unfactored snow load reaction at support A

$R_{A_{Snow}} = 1.8 \text{ kN}$

Maximum reaction at support B

$R_{B_{max}} = 66 \text{ kN}$

$R_{B_{min}} = 66 \text{ kN}$

Unfactored permanent load reaction at support B

$R_{B_{Permanent}} = 41.1 \text{ kN}$

Unfactored variable load reaction at support B

$R_{B_{Variable}} = 5.9 \text{ kN}$

Unfactored snow load reaction at support B

$R_{B_{Snow}} = 1.8 \text{ kN}$

Section details

Section type

UB 305x165x40 (British Steel Section Range 2022 (BS4-1))

Steel grade

S355

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element

$t = \max(t_r, t_w) = 10.2 \text{ mm}$

Nominal yield strength

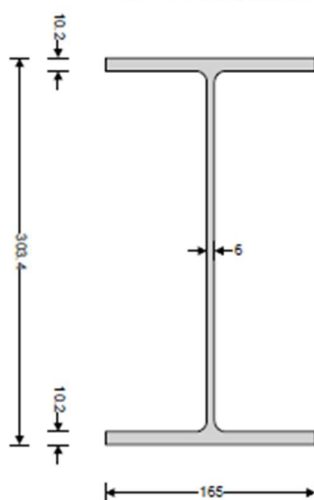
$f_y = 355 \text{ N/mm}^2$

Nominal ultimate tensile strength

$f_u = 470 \text{ N/mm}^2$

Modulus of elasticity

$E = 210000 \text{ N/mm}^2$



Partial factors - Section 6.1

Resistance of cross-sections

$\gamma_{M0} = 1.00$

Resistance of members to instability

$\gamma_{M1} = 1.00$

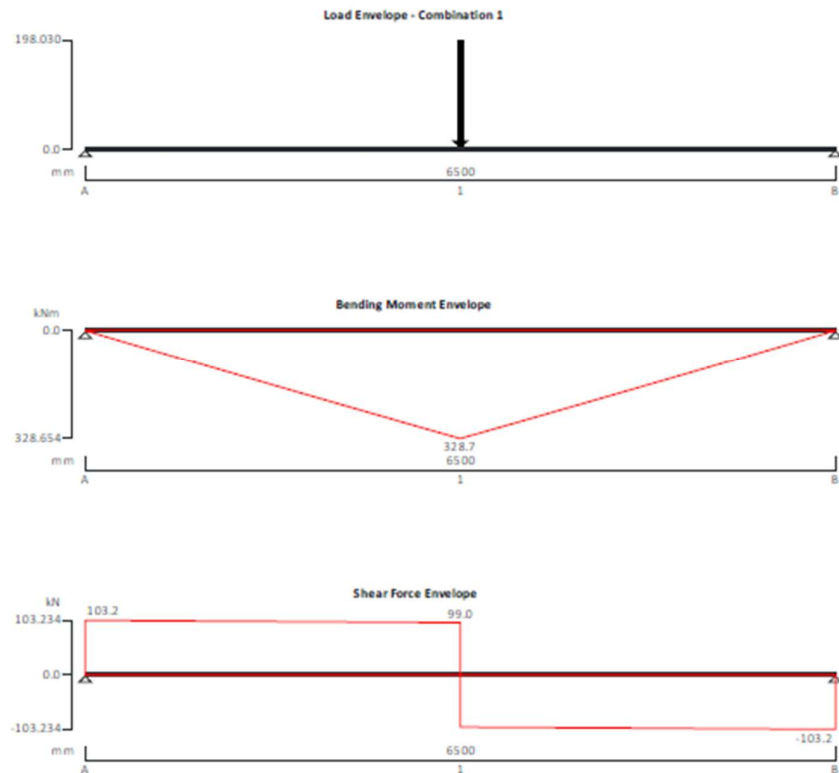
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	Description:	Structural Calculations	Checked by:	NM
Resistance of tensile members to fracture $\gamma_{M2} = 1.10$ Lateral restraint Span 1 has lateral restraint at supports only Effective length factors Effective length factor in major axis $K_y = 1.000$ Effective length factor in minor axis $K_z = 1.000$ Effective length factor for torsion $K_{LT,A} = 1.000$ $K_{LT,B} = 1.000$ Classification of cross sections - Section 5.5 $\varepsilon = \sqrt{235 \text{ N/mm}^2 / f_y} = 0.81$ Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3) Width of section $c = d = 265.2 \text{ mm}$ $c / t_w = 54.3 \times \varepsilon \leq 72 \times \varepsilon$ Class 1 Outstand flanges - Table 5.2 (sheet 2 of 3) Width of section $c = (b - t_w - 2 \times r) / 2 = 70.6 \text{ mm}$ $c / t_f = 8.5 \times \varepsilon \leq 9 \times \varepsilon$ Class 1 Section is class 1 Check shear - Section 6.2.6 Height of web $h_w = h - 2 \times t_f = 283 \text{ mm}$ Shear area factor $\eta = 1.000$ $h_w / t_w < 72 \times \varepsilon / \eta$ Shear buckling resistance can be ignored Design shear force $V_{Ed} = \max(\text{abs}(V_{max}), \text{abs}(V_{min})) = 66 \text{ kN}$ Shear area - cl 6.2.6(3) $A_v = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 2009 \text{ mm}^2$ Design shear resistance - cl 6.2.6(2) $V_{c,Rd} = V_{pl,Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{M0} = 411.7 \text{ kN}$ PASS - Design shear resistance exceeds design shear force Check bending moment major (y-y) axis - Section 6.2.5 Design bending moment $M_{Ed} = \max(\text{abs}(M_{s1_max}), \text{abs}(M_{s1_min})) = 99 \text{ kNm}$ Design bending resistance moment - eq 6.13 $M_{c,Rd} = M_{pl,Rd} = W_{ply} \times f_y / \gamma_{M0} = 221.2 \text{ kNm}$ Slenderness ratio for lateral torsional buckling Correction factor - Table 6.6 $k_c = 0.94$ $C_1 = 1 / k_c^2 = 1.132$ Curvature factor $g = \sqrt{1 - (I_z / I_y)} = 0.954$ Poissons ratio $\nu = 0.3$ Shear modulus $G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$ Unrestrained length $L = 1.0 \times L_{s1} = 6000 \text{ mm}$ Elastic critical buckling moment $M_{cr} = C_1 \times \pi^2 \times E \times I_z / (L^2 \times g) \times \sqrt{I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z)} = 115 \text{ kNm}$ Slenderness ratio for lateral torsional buckling $\bar{\lambda}_{LT} = \sqrt{(W_{ply} \times f_y / M_{cr})} = 1.387$ Limiting slenderness ratio $\bar{\lambda}_{LT,0} = 0.4$ $\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored Design resistance for buckling - Section 6.3.2.1 Buckling curve - Table 6.5 b Imperfection factor - Table 6.3 $\alpha_{LT} = 0.34$				

5.3. FLAT ROOF - PRIMARY MEMBER ANALYSIS

STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14



Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Applied loading

Beam loads

Permanent self weight of beam $\times 1$

Span 1 loads

Load From Intermediate Member - West Side - Variable point load

66.01 kN at 3250 mm

Load From Intermediate Member - East Side - Variable point load

66.01 kN at 3250 mm

Load combinations

Load combination 1

Support A

Permanent $\times 1.35$

Variable $\times 1.50$

Permanent $\times 1.35$

Variable $\times 1.50$

Support B

Permanent $\times 1.35$

Variable $\times 1.50$

Analysis results

Maximum moment

$M_{max} = 328.7 \text{ kNm}$

$M_{min} = 0 \text{ kNm}$

Maximum shear

$V_{max} = 103.2 \text{ kN}$

$V_{min} = -103.2 \text{ kN}$

Deflection

$\delta_{max} = 16 \text{ mm}$

$\delta_{min} = 0 \text{ mm}$

Maximum reaction at support A

$R_{A_{max}} = 103.2 \text{ kN}$

$R_{A_{min}} = 103.2 \text{ kN}$

Unfactored permanent load reaction at support A

$R_{A_{Permanent}} = 3.1 \text{ kN}$

Unfactored variable load reaction at support A

$R_{A_{Variable}} = 66 \text{ kN}$

Maximum reaction at support B

$R_{B_{max}} = 103.2 \text{ kN}$

$R_{B_{min}} = 103.2 \text{ kN}$

Unfactored permanent load reaction at support B

$R_{B_{Permanent}} = 3.1 \text{ kN}$

Unfactored variable load reaction at support B

$R_{B_{Variable}} = 66 \text{ kN}$

Section details

Section type

UC 305x305x97 (British Steel Section Range 2022 (BS4-1))

Steel grade

S355

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element

$t = \max(t_r, t_w) = 15.4 \text{ mm}$

Nominal yield strength

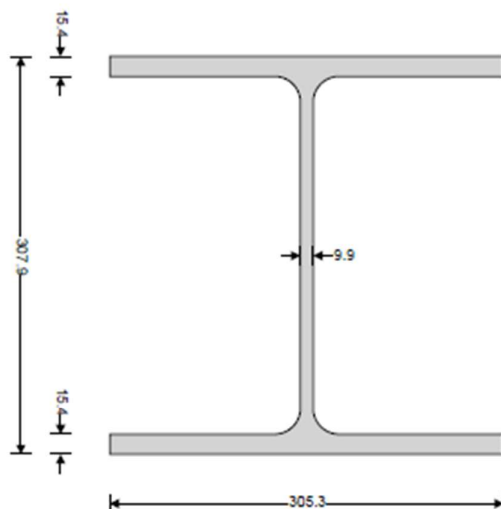
$f_y = 355 \text{ N/mm}^2$

Nominal ultimate tensile strength

$f_u = 470 \text{ N/mm}^2$

Modulus of elasticity

$E = 210000 \text{ N/mm}^2$



Partial factors - Section 6.1

Resistance of cross-sections

$\gamma_{M0} = 1.00$

Resistance of members to instability

$\gamma_{M1} = 1.00$

Resistance of tensile members to fracture

$\gamma_{M2} = 1.10$

Lateral restraint

Span 1 has lateral restraint at supports only

Effective length factors

Effective length factor in major axis

$K_y = 1.000$

Effective length factor in minor axis

$K_z = 1.000$

Effective length factor for torsion

$K_{LTA} = 1.000$

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	Description:	Structural Calculations	Checked by:	NM

$$K_{LT,B} = 1.000$$

Classification of cross sections - Section 5.5

$$\varepsilon = \sqrt{235 \text{ N/mm}^2 / f_y} = 0.81$$

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section

$$c = d = 237.1 \text{ mm}$$

$$c / t_w = 29.4 \times \varepsilon \leq 72 \times \varepsilon \quad \text{Class 1}$$

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section

$$c = (b - t_w - 2 \times r) / 2 = 127.7 \text{ mm}$$

$$c / t_f = 10.2 \times \varepsilon \leq 14 \times \varepsilon \quad \text{Class 3}$$

Section is class 3

Check shear - Section 6.2.6

Height of web

$$h_w = h - 2 \times t_f = 277.1 \text{ mm}$$

Shear area factor

$$\eta = 1.000$$

$$h_w / t_w < 72 \times \varepsilon / \eta$$

Shear buckling resistance can be ignored

Design shear force

$$V_{Ed} = \max(\text{abs}(V_{max}), \text{abs}(V_{min})) = 103.2 \text{ kN}$$

Shear area - cl 6.2.6(3)

$$A_v = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 3855 \text{ mm}^2$$

Design shear resistance - cl 6.2.6(2)

$$V_{pl,Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{M0} = 790.1 \text{ kN}$$

PASS - Design shear resistance exceeds design shear force

Check bending moment major (y-y) axis - Section 6.2.5

Design bending moment

$$M_{Ed} = \max(\text{abs}(M_{s1_max}), \text{abs}(M_{s1_min})) = 328.7 \text{ kNm}$$

Design bending resistance moment - eq 6.14

$$M_{c,Rd} = M_{el,Rd} = W_{el,y} \times f_y / \gamma_{M0} = 518.9 \text{ kNm}$$

Slenderness ratio for lateral torsional buckling

Correction factor - Table 6.6

$$k_c = 0.86$$

$$C_1 = 1 / k_c^2 = 1.352$$

Curvature factor

$$g = \sqrt{1 - (I_z / I_y)} = 0.822$$

Poissons ratio

$$\nu = 0.3$$

Shear modulus

$$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$$

Unrestrained length

$$L = 1.0 \times L_{s1} = 6500 \text{ mm}$$

Elastic critical buckling moment

$$M_{cr} = C_1 \times \pi^2 \times E \times I_z / (L^2 \times g) \times \sqrt{I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z)} = 1231.4 \text{ kNm}$$

Slenderness ratio for lateral torsional buckling

$$\bar{\lambda}_{LT} = \sqrt{W_{el,y} \times f_y / M_{cr}} = 0.649$$

Limiting slenderness ratio

$$\bar{\lambda}_{LT,0} = 0.4$$

$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored

Design resistance for buckling - Section 6.3.2.1

Buckling curve - Table 6.5

$$b$$

Imperfection factor - Table 6.3

$$\alpha_{LT} = 0.34$$

Correction factor for rolled sections

$$\beta = 0.75$$

LTB reduction determination factor

$$\phi_{LT} = 0.5 \times [1 + \alpha_{LT} \times (\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta \times \bar{\lambda}_{LT}^2] = 0.700$$

LTB reduction factor - eq 6.57

$$\chi_{LT} = \min(1 / [\phi_{LT} + \sqrt{(\phi_{LT}^2 - \beta \times \bar{\lambda}_{LT}^2)}], 1, 1 / \bar{\lambda}_{LT}^2) = 0.894$$

Modification factor

$$f = \min(1 - 0.5 \times (1 - k_c) \times [1 - 2 \times (\bar{\lambda}_{LT} - 0.8)^2], 1) = 0.933$$

Modified LTB reduction factor - eq 6.58

$$\chi_{LT,mod} = \min(\chi_{LT} / f, 1) = 0.958$$

Design buckling resistance moment - eq 6.55

$$M_{b,Rd} = \chi_{LT,mod} \times W_{el,y} \times f_y / \gamma_{M1} = 497.4 \text{ kNm}$$

PASS - Design buckling resistance moment exceeds design bending moment

**Structural Calculations – P001-TRN-V1-ZZ-RP-S-001_I1**

Sheet No.

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Client:

ACE Capital projects LTD

Date:

25/03/2026

Project:

Centre of Excellence for Construction

by:

TM - 2206144

Description:

Structural Calculations

Checked by:

NM

Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

Limiting deflection

$$\delta_{lim} = L_{s1} / 360 = 18.1 \text{ mm}$$

Maximum deflection span 1

$$\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min})) = 15.983 \text{ mm}$$

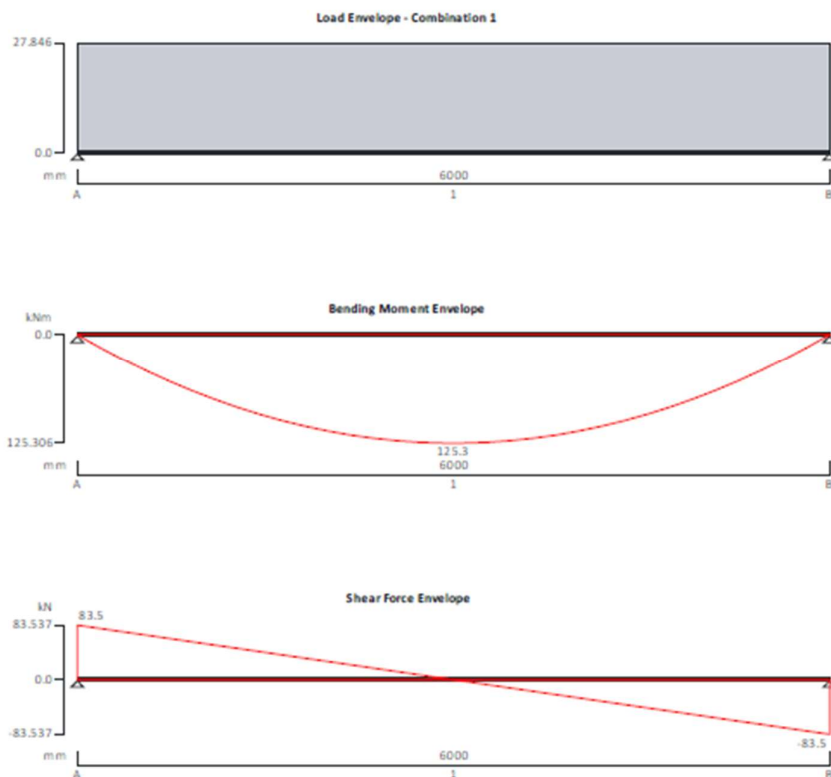
PASS - Maximum deflection does not exceed deflection limit

5.4. FIRST FLOOR - INTERMEDIATE MEMBER ANALYSIS

STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14



Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Applied loading

Beam loads

Permanent self weight of beam $\times 1$

Span 1 loads

Concrete (Wet) - Permanent UDL 8.55 kN/m from 0 mm to 6000 mm

Services - Permanent UDL 0.49 kN/m from 0 mm to 6000 mm

Ribdeck Flooring - Permanent UDL 0.39 kN/m from 0 mm to 6000 mm

Structural Engineers Handbook - Page 96 - Variable UDL 9.75 kN/m

from 0 mm to 6000 mm

Load combinations

Load combination 1

Support A

Permanent $\times 1.35$

Variable $\times 1.50$

Permanent $\times 1.35$

Support B

Variable $\times 1.50$

Permanent $\times 1.35$

Variable $\times 1.50$

Analysis results

Maximum moment

$M_{\max} = 125.3 \text{ kNm}$

$M_{\min} = 0 \text{ kNm}$

Maximum moment span 1 segment 1

$M_{s1_seg1_max} = 125.3 \text{ kNm}$

$M_{s1_seg1_min} = 0 \text{ kNm}$

Maximum moment span 1 segment 2

$M_{s1_seg2_max} = 125.3 \text{ kNm}$

$M_{s1_seg2_min} = 0 \text{ kNm}$

Maximum shear

$V_{\max} = 83.5 \text{ kN}$

$V_{\min} = -83.5 \text{ kN}$

Maximum shear span 1 segment 1

$V_{s1_seg1_max} = 83.5 \text{ kN}$

$V_{s1_seg1_min} = 0 \text{ kN}$

Maximum shear span 1 segment 2

$V_{s1_seg2_max} = 0 \text{ kN}$

$V_{s1_seg2_min} = -83.5 \text{ kN}$

Deflection segment 3

$\delta_{\max} = 14.2 \text{ mm}$

$\delta_{\min} = 0 \text{ mm}$

Maximum reaction at support A

$R_{A_max} = 83.5 \text{ kN}$

$R_{A_min} = 83.5 \text{ kN}$

Unfactored permanent load reaction at support A

$R_{A_Permanent} = 29.4 \text{ kN}$

Unfactored variable load reaction at support A

$R_{A_Variable} = 29.3 \text{ kN}$

Maximum reaction at support B

$R_{B_max} = 83.5 \text{ kN}$

$R_{B_min} = 83.5 \text{ kN}$

Unfactored permanent load reaction at support B

$R_{B_Permanent} = 29.4 \text{ kN}$

Unfactored variable load reaction at support B

$R_{B_Variable} = 29.3 \text{ kN}$

Section details

Section type

UB 254x146x37 (British Steel Section Range 2022 (BS4-1))

Steel grade

S355

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element

$t = \max(t_f, t_w) = 10.9 \text{ mm}$

Nominal yield strength

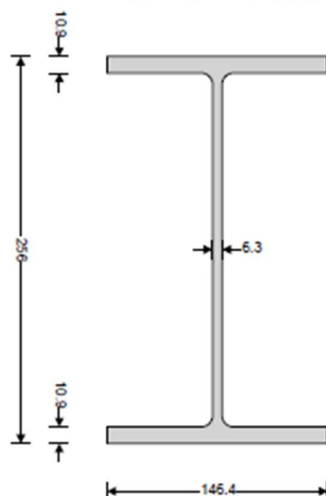
$f_y = 355 \text{ N/mm}^2$

Nominal ultimate tensile strength

$f_u = 470 \text{ N/mm}^2$

Modulus of elasticity

$E = 210000 \text{ N/mm}^2$



Partial factors - Section 6.1

Resistance of cross-sections

$\gamma_{M0} = 1.00$

Resistance of members to instability

$\gamma_{M1} = 1.00$

Resistance of tensile members to fracture

$\gamma_{M2} = 1.10$

Lateral restraint

Span 1 has lateral restraint at supports plus midspan

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Effective length factors

Effective length factor in major axis	$K_y = 1.000$
Effective length factor in minor axis	$K_z = 1.000$
Effective length factor for torsion	$K_{LT,A} = 1.000$
	$K_{LT,B} = 1.000$

Classification of cross sections - Section 5.5

$$\varepsilon = \sqrt{235 \text{ N/mm}^2 / f_y} = 0.81$$

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section	$c = d = 219 \text{ mm}$	
	$c / t_w = 42.7 \times \varepsilon \leq 72 \times \varepsilon$	Class 1

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section	$c = (b - t_w - 2 \times r) / 2 = 62.5 \text{ mm}$	
	$c / t_f = 7.0 \times \varepsilon \leq 9 \times \varepsilon$	Class 1

Section is class 1

Check shear - Section 6.2.6

Height of web	$h_w = h - 2 \times t_f = 234.2 \text{ mm}$
Shear area factor	$\eta = 1.000$
	$h_w / t_w < 72 \times \varepsilon / \eta$

Shear buckling resistance can be ignored

Design shear force	$V_{Ed} = \max(\text{abs}(V_{max}), \text{abs}(V_{min})) = 83.5 \text{ kN}$
Shear area - cl 6.2.6(3)	$A_w = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 1759 \text{ mm}^2$
Design shear resistance - cl 6.2.6(2)	$V_{c,Rd} = V_{pl,Rd} = A_w \times (f_y / \sqrt{3}) / \gamma_{M0} = 360.6 \text{ kN}$

PASS - Design shear resistance exceeds design shear force

Check bending moment at span 1 segment 1 major (y-y) axis - Section 6.2.5

Design bending moment	$M_{Ed} = \max(\text{abs}(M_{s1_seg1_max}), \text{abs}(M_{s1_seg1_min})) = 125.3 \text{ kNm}$
Design bending resistance moment - eq 6.13	$M_{c,Rd} = M_{pl,Rd} = W_{ply} \times f_y / \gamma_{M0} = 171.5 \text{ kNm}$

Slenderness ratio for lateral torsional buckling

Correction factor - Table 6.6	$k_c = 0.873$
	$C_1 = 1 / k_c^2 = 1.311$
Curvature factor	$g = \sqrt{1 - (I_z / I_y)} = 0.947$
Poissons ratio	$\nu = 0.3$
Shear modulus	$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$
Unrestrained length	$L = 1.0 \times L_{s1_seg1} = 3000 \text{ mm}$
Elastic critical buckling moment	$M_{cr} = C_1 \times \pi^2 \times E \times I_z / (L^2 \times g) \times \sqrt{I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z)} = 284.4 \text{ kNm}$
Slenderness ratio for lateral torsional buckling	$\bar{\lambda}_{LT} = \sqrt{(W_{ply} \times f_y / M_{cr})} = 0.777$
Limiting slenderness ratio	$\bar{\lambda}_{LT,0} = 0.4$

$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored

Design resistance for buckling - Section 6.3.2.1

Buckling curve - Table 6.5	b
Imperfection factor - Table 6.3	$\alpha_{LT} = 0.34$
Correction factor for rolled sections	$\beta = 0.75$
LTB reduction determination factor	$\phi_{LT} = 0.5 \times [1 + \alpha_{LT} \times (\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta \times \bar{\lambda}_{LT}^2] = 0.790$
LTB reduction factor - eq 6.57	$\chi_{LT} = \min(1 / [\phi_{LT} + \sqrt{(\phi_{LT}^2 - \beta \times \bar{\lambda}_{LT}^2)}], 1, 1 / \bar{\lambda}_{LT}^2) = 0.830$

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Modification factor

$$f = \min(1 - 0.5 \times (1 - k_c) \times [1 - 2 \times (\bar{\lambda}_{LT} - 0.8)^2], 1) = 0.937$$

Modified LTB reduction factor - eq 6.58

$$\chi_{LT,mod} = \min(\chi_{LT} / f, 1) = 0.886$$

Design buckling resistance moment - eq 6.55

$$M_{b,Rd} = \chi_{LT,mod} \times W_{ply} \times f_y / \gamma_{M1} = 152 \text{ kNm}$$

PASS - Design buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

Limiting deflection

$$\delta_{lim} = L_{s1} / 360 = 16.7 \text{ mm}$$

Maximum deflection span 1

$$\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min})) = 14.15 \text{ mm}$$

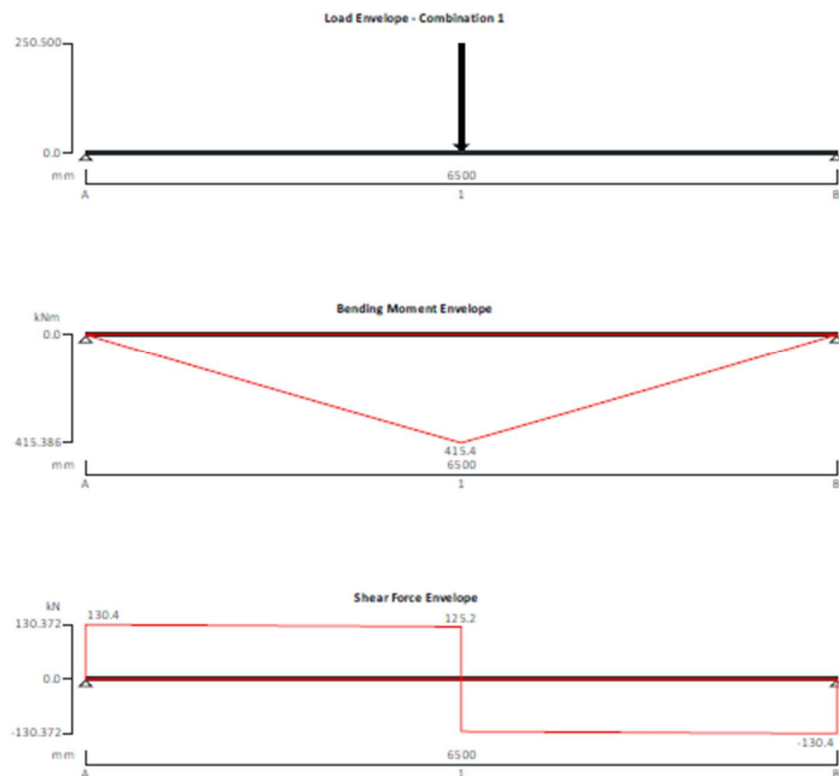
PASS - Maximum deflection does not exceed deflection limit

5.5. FIRST FLOOR - PRIMARY MEMBER ANALYSIS

STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14



Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Applied loading

Beam loads

Permanent self weight of beam $\times 1$

Span 1 loads

Load From Intermediate Member - West Side - Variable point load
83.5 kN at 3250 mm

Load From Intermediate Member - East Side - Variable point load
83.5 kN at 3250 mm

Load combinations

Load combination 1

Support A

Permanent $\times 1.35$

Variable $\times 1.50$

Permanent $\times 1.35$

Variable $\times 1.50$

Support B

Permanent $\times 1.35$

Variable $\times 1.50$

Analysis results

Maximum moment

$M_{max} = 415.4 \text{ kNm}$

$M_{min} = 0 \text{ kNm}$

Maximum moment span 1 segment 1

$M_{s1_seg1_max} = 415.4 \text{ kNm}$

$M_{s1_seg1_min} = 0 \text{ kNm}$

Maximum moment span 1 segment 2

$M_{s1_seg2_max} = 415.4 \text{ kNm}$

$M_{s1_seg2_min} = 0 \text{ kNm}$

Maximum shear

$V_{max} = 130.4 \text{ kN}$

$V_{min} = -130.4 \text{ kN}$

Maximum shear span 1 segment 1

$V_{s1_seg1_max} = 130.4 \text{ kN}$

$V_{s1_seg1_min} = -125.2 \text{ kN}$

Maximum shear span 1 segment 2

$V_{s1_seg2_max} = 0 \text{ kN}$

$V_{s1_seg2_min} = -130.4 \text{ kN}$

Deflection segment 3

$\delta_{max} = 16.3 \text{ mm}$

$\delta_{min} = 0 \text{ mm}$

Maximum reaction at support A

$R_{A_max} = 130.4 \text{ kN}$

$R_{A_min} = 130.4 \text{ kN}$

Unfactored permanent load reaction at support A

$R_{A_Permanent} = 3.8 \text{ kN}$

Unfactored variable load reaction at support A

$R_{A_Variable} = 83.5 \text{ kN}$

Maximum reaction at support B

$R_{B_max} = 130.4 \text{ kN}$

$R_{B_min} = 130.4 \text{ kN}$

Unfactored permanent load reaction at support B

$R_{B_Permanent} = 3.8 \text{ kN}$

Unfactored variable load reaction at support B

$R_{B_Variable} = 83.5 \text{ kN}$

Section details

Section type

UC 305x305x118 (British Steel Section Range 2022 (BS4-1))

Steel grade

S355

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element

$t = \max(t_r, t_w) = 18.7 \text{ mm}$

Nominal yield strength

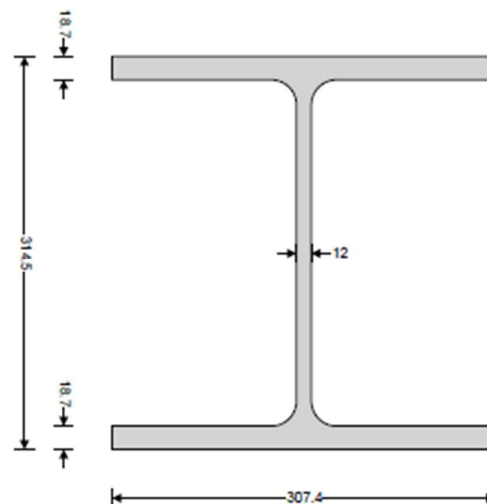
$f_y = 345 \text{ N/mm}^2$

Nominal ultimate tensile strength

$f_u = 470 \text{ N/mm}^2$

Modulus of elasticity

$E = 210000 \text{ N/mm}^2$



Partial factors - Section 6.1

Resistance of cross-sections

$\gamma_{M0} = 1.00$

Resistance of members to instability

$\gamma_{M1} = 1.00$

Resistance of tensile members to fracture

$\gamma_{M2} = 1.10$

Lateral restraint

Span 1 has lateral restraint at supports plus midspan

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Effective length factors

Effective length factor in major axis

$$K_y = 1.000$$

Effective length factor in minor axis

$$K_z = 1.000$$

Effective length factor for torsion

$$K_{LT,A} = 1.000$$

$$K_{LT,B} = 1.000$$

Classification of cross sections - Section 5.5

$$\varepsilon = \sqrt{235 \text{ N/mm}^2 / f_y} = 0.83$$

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section

$$c = d = 237.1 \text{ mm}$$

$$c / t_w = 23.9 \times \varepsilon \leq 72 \times \varepsilon$$

Class 1

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section

$$c = (b - t_w - 2 \times r) / 2 = 127.7 \text{ mm}$$

$$c / t_f = 8.3 \times \varepsilon \leq 9 \times \varepsilon$$

Class 1

Section is class 1
Check shear - Section 6.2.6

Height of web

$$h_w = h - 2 \times t_f = 277.1 \text{ mm}$$

Shear area factor

$$\eta = 1.000$$

$$h_w / t_w < 72 \times \varepsilon / \eta$$

Shear buckling resistance can be ignored

Design shear force

$$V_{Ed} = \max(\text{abs}(V_{max}), \text{abs}(V_{min})) = 130.4 \text{ kN}$$

Shear area - cl 6.2.6(3)

$$A_v = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 4641 \text{ mm}^2$$

Design shear resistance - cl 6.2.6(2)

$$V_{c,Rd} = V_{pl,Rd} = A_v \times (f_y / \sqrt{3}) / \gamma_{M0} = 924.4 \text{ kN}$$

PASS - Design shear resistance exceeds design shear force
Check bending moment at span 1 segment 1 major (y-y) axis - Section 6.2.5

Design bending moment

$$M_{Ed} = \max(\text{abs}(M_{s1_seg1_max}), \text{abs}(M_{s1_seg1_min})) = 415.4 \text{ kNm}$$

Design bending resistance moment - eq 6.13

$$M_{c,Rd} = M_{pl,Rd} = W_{pl,y} \times f_y / \gamma_{M0} = 682 \text{ kNm}$$

Slenderness ratio for lateral torsional buckling

Correction factor - Table 6.6

$$k_c = 0.77$$

$$C_1 = 1 / k_c^2 = 1.687$$

Curvature factor

$$g = \sqrt{1 - (I_z / I_y)} = 0.822$$

Poissons ratio

$$\nu = 0.3$$

Shear modulus

$$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$$

Unrestrained length

$$L = 1.0 \times L_{s1_seg1} = 3250 \text{ mm}$$

Elastic critical buckling moment

$$M_{cr} = C_1 \times \pi^2 \times E \times I_z / (L^2 \times g) \times \sqrt{I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z)} = 6280.5 \text{ kNm}$$

Slenderness ratio for lateral torsional buckling

$$\bar{\lambda}_{LT} = \sqrt{W_{pl,y} \times f_y / M_{cr}} = 0.33$$

Limiting slenderness ratio

$$\bar{\lambda}_{LT,0} = 0.4$$

 $\bar{\lambda}_{LT} < \bar{\lambda}_{LT,0}$ - Lateral torsional buckling can be ignored

PASS - Design bending resistance moment exceeds design bending moment
Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

Limiting deflection

$$\delta_{lim} = L_{s1} / 360 = 18.1 \text{ mm}$$

Maximum deflection span 1

$$\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min})) = 16.292 \text{ mm}$$

PASS - Maximum deflection does not exceed deflection limit

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5.6. COLUMN MEMBER ANALYSIS

STEEL MEMBER ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

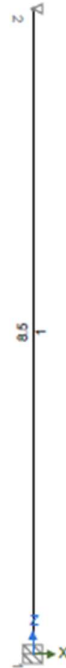
Tedds calculation version 4.4.10

ANALYSIS

Tedds calculation version 1.0.37

Geometry

Geometry (m) - Steel (EC3) - UC 305x305x129



Span	Length (m)	Section	Start Support	End Support
1	8.5	UC 305x305x129	Fixed	Pinned
UC 305x305x129: Area 167 cm ² , Inertia Major 31035 cm ⁴ , Inertia Minor 10041 cm ⁴ , Shear area parallel to Minor 42 cm ² , Shear area parallel to Major = 114 cm ²				
Steel (EC3): Density 7850 kg/m ³ , Youngs 210 kN/mm ² , Shear 80.8 kN/mm ² , Thermal 0.000012 °C ⁻¹				

Loading

Self weight included



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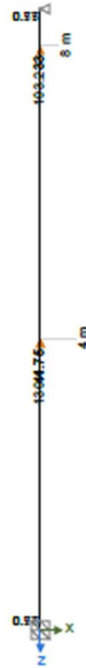
Description:

Structural Calculations

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Permanent - Loading (kN/m,kN)



Wind - Loading (kN/m)



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Description: Structural Calculations

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Load combination factors

Load combination	Self Weight	Permanent	Imposed	Wind
1.35G + 1.5Q + 1.5RQ (Strength)	1.35	1.35	1.50	1.00
1.0G + 1.0Q + 1.0RQ (Service)	1.00	1.00	1.00	1.00

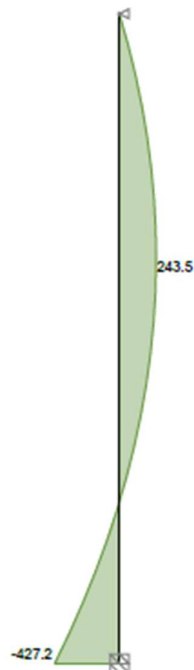
Member Loads

Member	Load case	Load Type	Orientation	Description
Column	Permanent	Point load	LocalX	103.2 kN at 8 m
Column	Permanent	Point load	LocalX	130.4 kN at 4 m
Column	Permanent	UDL	LocalZ	0.57 kN/m at 0 m to 8.5 m
Column	Permanent	UDL	LocalZ	0.75 kN/m at 0 m to 8.5 m
Column	Permanent	Point load	LocalX	33 kN at 8 m
Column	Permanent	Point load	LocalX	33 kN at 8 m
Column	Permanent	Point load	LocalX	41.75 kN at 4 m
Column	Permanent	Point load	LocalX	41.75 kN at 4 m
Column	Wind	UDL	LocalZ	45.9 kN/m at 0 m to 8.5 m

Results

Forces

Strength combinations - Moment envelope (kNm)



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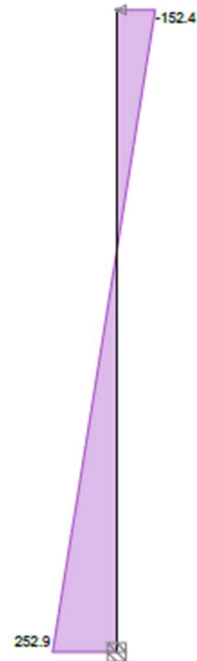
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Description: Structural Calculations

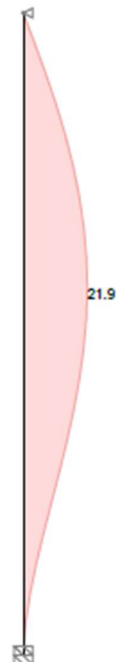
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Strength combinations - Shear envelope (kN)



Service combinations - Deflection envelope (mm)



Partial factors - Section 6.1

Resistance of cross-sections

$\gamma_{M0} = 1$

Resistance of members to instability

$\gamma_{M1} = 1$

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Description: Structural Calculations

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Resistance of tensile members to fracture

$$\gamma_{M2} = 1.1$$

Column design

Section details

Section type

UC 305x305x129 (British Steel Section Range 2022)

Steel grade - EN 10025-2:2004

S355

Nominal thickness of element

$$t_{nom} = \max(t_f, t_w) = 20.6 \text{ mm}$$

Nominal yield strength

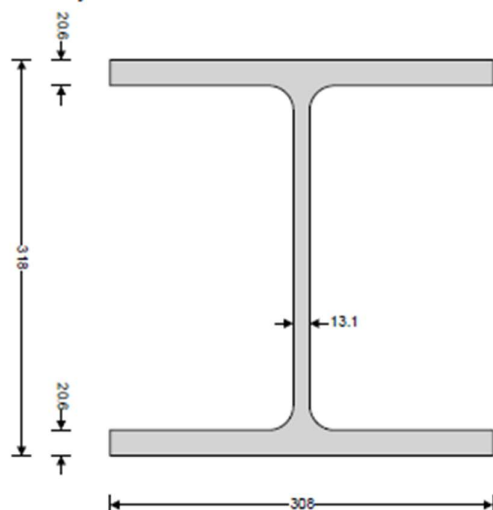
$$f_y = 345 \text{ N/mm}^2$$

Nominal ultimate tensile strength

$$f_u = 470 \text{ N/mm}^2$$

Modulus of elasticity

$$E = 210000 \text{ N/mm}^2$$



UC 305x305x129 (British Steel Section Range 2022)

Section depth, h, 318 mm

Section breadth, b, 308 mm

Mass of section, Mass, 130.8 kg/m

Flange thickness, t_f, 20.6 mm

Web thickness, t_w, 13.1 mm

Root radius, r, 20 mm

Area of section, A, 16659 mm²

Radius of gyration about y-axis, i_y, 136.491 mm

Radius of gyration about z-axis, i_z, 77.638 mm

Elastic section modulus about y-axis, W_{el,y}, 1951908 mm³

Elastic section modulus about z-axis, W_{el,z}, 652038 mm³

Plastic section modulus about y-axis, W_{pl,y}, 2183858 mm³

Plastic section modulus about z-axis, W_{pl,z}, 992755 mm³

Second moment of area about y-axis, I_y, 310353294 mm⁴

Second moment of area about z-axis, I_z, 100413881 mm⁴

Lateral restraint

Both flanges have lateral restraint at supports plus 4000 & 8000 mm

Consider Combination 1 - 1.35G + 1.5Q + 1.5RQ (Strength)

Classification of cross sections - Section 5.5

$$\epsilon = \sqrt{235 \text{ N/mm}^2 / f_y} = 0.83$$

Internal compression parts subject to bending and compression - Table 5.2 (sheet 1 of 3)

Width of section

$$c = d = 236.8 \text{ mm}$$

$$\alpha = \min([h / 2 + N_{Ed} / (2 \times t_w \times f_y) - (t_f + r)] / c, 1) = 0.661$$

$$c / t_w = 18.1 = 21.9 \times \epsilon \leq 396 \times \epsilon / (13 \times \alpha - 1) \quad \text{Class 1}$$

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section

$$c = (b - t_w - 2 \times r) / 2 = 127.5 \text{ mm}$$

$$c / t_f = 6.2 = 7.5 \times \epsilon \leq 9 \times \epsilon \quad \text{Class 1}$$

Section is class 1

Check tension - Section 6.2.3

Design tension force

$$N_{Ed} = 159 \text{ kN}$$

Design resistance of section - eq 6.6

$$N_{t,Rd} = N_{pl,Rd} = A \times f_y / \gamma_{M0} = 5747.4 \text{ kN}$$

$$N_{Ed} / N_{t,Rd} = 0.028$$

PASS - Design tension resistance exceeds design tension

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Check design at start of span

Check shear - Section 6.2.6

Height of web

$$h_w = h - 2 \times t_f = 276.8 \text{ mm} \quad \eta = 1.000$$

$$h_w / t_w = 21.1 = 25.6 \times \varepsilon / \eta < 72 \times \varepsilon / \eta$$

Shear buckling resistance can be ignored

Design shear force

$$V_{y,Ed} = 252.9 \text{ kN}$$

Shear area - cl 6.2.6(3)

$$A_w = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) = 5063 \text{ mm}^2$$

Design shear resistance - cl 6.2.6(2)

$$V_{c,y,Rd} = V_{pl,y,Rd} = A_w \times (f_y / \sqrt{3}) / \gamma_{M0} = 1008.5 \text{ kN}$$

$$V_{y,Ed} / V_{c,y,Rd} = 0.251$$

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment

$$M_{y,Ed} = 427.2 \text{ kNm}$$

Design bending resistance moment - eq 6.13

$$M_{c,y,Rd} = M_{pl,y,Rd} = W_{ply} \times f_y / \gamma_{M0} = 753.4 \text{ kNm}$$

$$M_{y,Ed} / M_{c,y,Rd} = 0.567$$

PASS - Design bending resistance moment exceeds design bending moment

Slenderness ratio for lateral torsional buckling

Correction factor - Table 6.6

$$k_c = 0.587$$

$$C_1 = 1 / k_c^2 = 2.899$$

Poissons ratio

$$\nu = 0.3$$

Shear modulus

$$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$$

Unrestrained effective length

$$L = 1.0 \times L_{m1_s1_seg1_B} = 4000 \text{ mm}$$

Elastic critical buckling moment

$$M_{cr} = C_1 \times \pi^2 \times E \times I_z / L^2 \times \sqrt{(I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z))} = 7159 \text{ kNm}$$

Slenderness ratio for lateral torsional buckling

$$\bar{\lambda}_{LT} = \sqrt{(W_{ply} \times f_y / M_{cr})} = 0.324$$

Limiting slenderness ratio

$$\bar{\lambda}_{LT,0} = 0.4$$

$\bar{\lambda}_{LT} < \bar{\lambda}_{LT,0}$ - Lateral torsional buckling can be ignored

Check bending and axial force - Section 6.2.9

Bending and axial force check - eq.6.33 & eq.6.34 $N_{y,lim} = \min(0.25 \times N_{pl,Rd}, 0.5 \times h_w \times t_w \times f_y / \gamma_{M0}) = 625.5 \text{ kN}$

$$N_{Ed} / N_{y,lim} = 0.254$$

Allowance need not be made for the effect of the axial force on the plastic resistance moment about the y-y axis

Check design 5304 mm along span

Check bending moment - Section 6.2.5

Design bending moment

$$M_{y,Ed} = 243.5 \text{ kNm}$$

Design bending resistance moment - eq 6.13

$$M_{c,y,Rd} = M_{pl,y,Rd} = W_{ply} \times f_y / \gamma_{M0} = 753.4 \text{ kNm}$$

$$M_{y,Ed} / M_{c,y,Rd} = 0.323$$

PASS - Design bending resistance moment exceeds design bending moment

Slenderness ratio for lateral torsional buckling

Correction factor - Table 6.6

$$k_c = 0.954$$

$$C_1 = 1 / k_c^2 = 1.1$$

Poissons ratio

$$\nu = 0.3$$

Shear modulus

$$G = E / [2 \times (1 + \nu)] = 80769 \text{ N/mm}^2$$

Unrestrained effective length

$$L = 1.0 \times L_{m1_s1_seg2_T} = 4000 \text{ mm}$$

Elastic critical buckling moment

$$M_{cr} = C_1 \times \pi^2 \times E \times I_z / L^2 \times \sqrt{(I_w / I_z + L^2 \times G \times I_t / (\pi^2 \times E \times I_z))} = 2716.2 \text{ kNm}$$

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Slenderness ratio for lateral torsional buckling

$$\bar{\lambda}_{LT} = \sqrt{W_{ply} \times f_y / M_{cr}} = 0.527$$

Limiting slenderness ratio

$$\bar{\lambda}_{LT,0} = 0.4$$

$\bar{\lambda}_{LT} > \bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored

Check buckling resistance - Section 6.3.2.1

Buckling curve - Table 6.5

b

Imperfection factor - Table 6.3

$$\alpha_{LT} = 0.34$$

Correction factor for rolled sections

$$\beta = 0.75$$

LTB reduction determination factor

$$\phi_{LT} = 0.5 \times [1 + \alpha_{LT} \times (\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta \times \bar{\lambda}_{LT}^2] = 0.626$$

LTB reduction factor - eq 6.57

$$\chi_{LT} = \min(1 / [\phi_{LT} + \sqrt{\phi_{LT}^2 - \beta \times \bar{\lambda}_{LT}^2}], 1, 1 / \bar{\lambda}_{LT}^2) = 0.949$$

Modification factor

$$f = \min(1 - 0.5 \times (1 - k_c) \times [1 - 2 \times (\bar{\lambda}_{LT} - 0.8)^2], 1) = 0.980$$

Modified LTB reduction factor - eq 6.58

$$\chi_{LT,mod} = \min(\chi_{LT} / f, 1, 1 / \bar{\lambda}_{LT}^2) = 0.968$$

Design buckling resistance moment - eq 6.55

$$M_{b,y,Rd} = \chi_{LT,mod} \times W_{ply} \times f_y / \gamma_{M1} = 729.5 \text{ kNm}$$

$$M_{y,Ed} / M_{b,y,Rd} = 0.334$$

PASS - Design buckling resistance moment exceeds design bending moment

Check combined bending and compression - Section 6.3.3

Equivalent uniform moment factors - Table B.3

$$\psi_y = 0 \text{ kNm} / -427.193 \text{ kNm} = 0.000$$

$$\alpha_y = 217.031 \text{ kNm} / -427.193 \text{ kNm} = -0.508$$

$$C_{my} = \max(0.1 - 0.8 \times \alpha_y, 0.4) = 0.506$$

$$\psi_{LT} = 70.235 \text{ kNm} / 202.977 \text{ kNm} = 0.346$$

$$\alpha_{LT} = 202.977 \text{ kNm} / 231.97 \text{ kNm} = 0.875$$

$$C_{mLT} = 0.95 + 0.05 \times \alpha_{LT} = 0.994$$

Interaction factors k_{ij} for members susceptible to torsional deformations - Table B.2

Characteristic moment resistance

$$M_{y,Rk} = W_{ply} \times f_y = 753.4 \text{ kNm}$$

Characteristic moment resistance

$$M_{z,Rk} = W_{pl,z} \times f_y = 342.5 \text{ kNm}$$

Characteristic resistance to normal force

$$N_{Rk} = A \times f_y = 5747.4 \text{ kN}$$

Interaction factors

$$k_{yy} = C_{my} \times (1 + \min(\bar{\lambda}_y - 0.2, 0.8) \times N_{Ed} / (\chi_y \times N_{Rk} / \gamma_{M1})) = 0.515$$

$$k_{zy} = 1 - 0.1 \times \min(1, \bar{\lambda}_z) \times N_{Ed} / ((C_{mLT} - 0.25) \times \chi_z \times N_{Rk} / \gamma_{M1}) = 0.997$$

Interaction formulae - eq 6.61 & eq 6.62

$$N_{Ed} / (\chi_y \times N_{Rk} / \gamma_{M1}) + k_{yy} \times M_{y,Ed} / (\chi_{LT} \times M_{y,Rk} / \gamma_{M1}) = 0.205$$

$$N_{Ed} / (\chi_z \times N_{Rk} / \gamma_{M1}) + k_{zy} \times M_{y,Ed} / (\chi_{LT} \times M_{y,Rk} / \gamma_{M1}) = 0.368$$

PASS - Combined bending and compression checks are satisfied

Consider Combination 2 - 1.0G + 1.0Q + 1.0RQ (Service)

Check design 4883 mm along span

Check y-y axis deflection - Section 7.2.1

Maximum deflection

$$\delta_y = 21.9 \text{ mm}$$

Allowable deflection

$$\delta_{y,Allowable} = L_{m1,s1} / 360 = 23.6 \text{ mm}$$

$$\delta_y / \delta_{y,Allowable} = 0.929$$

PASS - Allowable deflection exceeds design deflection

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6. SUMMARY

The following analysis undertaken has considered the transfer the loads from the pitched roof down to ground level, thus showing the capability to read standards and undertake analysis to transfer the load through the structure down to the foundations.

The following assumptions have been made for the analysis:-

- 1) Additional bracing would be required for the structure to avoid structural sway against the horizontal actions. This has not been included.
- 2) Connection Details have not been included; this is to be complete by the contractor undertaking the steelwork fabrication.

It has been determined that all structures are suitably designed to resist the required loading known at this stage of the project. The summary of the calculation results can be found within Table below:-

Table 16 - Summary of Results

Member Type	Critical Failure Method	Utilisation	PASS / FAIL
Pitched Roof Member	Bending Moment (y-y)	93.8 %	PASS
Green Roof - Intermediate Member	Deflection	84.9 %	PASS
Green Roof - Primary Member	Deflection	88.5 %	PASS
First Floor - Intermediate Member	Bending Moment (y-y)	92.5 %	PASS
First Floor - Primary Member	Deflection	90.2 %	PASS
Column Member	Bending Resistance (y-y)	56.7 %	PASS

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