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STRUCTURAL CALCULATIONS

BASEMENT DESIGN AT
74 FORTUNE GREEN ROAD
NW6 1DS

Project No: EX18/132/07

Revision	Date	Changes
-	13.08.18	Issued to Architect

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Sheet	**:Structure/ 2 - Rev -**
Made By	**: K Papadimitriou**
Date	**: August 2018**
Checked	**: DJS**
Office	**: East Anglia** Tel **:01473 487047**

General Construction Notes and Guidance on using these Calculations

1. Calculations are not to be used for the purpose of ordering materials and should only be used for Building Regulations submissions. All dimensions should be checked by the contractor on site.

2. All steelwork to be mechanically wire brushed and painted two coats of red oxide. Steelwork located in the cavity or below DPC to be suitably protected with 2 coats of bituminous paint.

3. All steelwork connections to use grade 8.8 bolts unless stated otherwise. These are to be spanner tightened using the appropriate podger spanner (min length 460mm) or suitable power tools in accordance with BS2583. If a torque wrench is used the torque applied should be around 90Nm for M16 bolts, 110Nm for M20 & 130Nm for M24.

4. All timber to be grade C24 (SC4), unless stated otherwise. Preservative treated to Architects details.

5. To be read in conjunction with Architects drawings, any inconsistencies between the drawings should be reported. If any site conditions or existing details are found that may affect the structural design, JMS Consulting Engineers are to be notified immediately.

6. For details of fire protection to steelwork, see Architects drawings.

7. The Contractor is to ensure that all existing construction is adequately supported, using needles and props as required. Where a new beam supports the existing construction, adequate pre-load is to be applied and suitable packs such as driven dry-slate introduced, then pointed up with mortar.

8. All blockwork to be 7.3 N/mm^2 in class III mortar below DPC in accordance with BS 5628 : Part 3 : 2005 or suitable 7.0 N/mm^2 foundation quality blocks in class II mortar in accordance with the manufacturer's instructions. All brickwork below DPC to be Engineering Bricks DPC in accordance with BS 5628 : Part 3 : 2005.

9. The project requires the introduction of heavy structural elements such as steel beams or concrete lintels. Although the Construction (Design and Management) Regulation 1994 would not normally apply to this type of construction, the designer still has an obligation to foresee risks and bring to the attention of the builder such risks. In consequence, the builder is to take into consideration the placement of all structural elements, ensuring that the method of lifting and placement is safely carried out. Responsibility for this element lies with the Contractor. As the existing walls need to be propped in order to introduce some of the lintels, this should also be considered in relationship to the risk assessment of the Contractor. Safe working procedures must be adopted. Responsibility for this element lies with the Contractor. Splice details for long-span beams can often be accommodated if required.

10. All construction products should be CE marked in accordance current legislation. This includes all fabricated structural steelwork in accordance with BS EN 1090-1 and BS EN 1090-2. The consequence class is CC2 unless noted otherwise. The service class is SC1 for all buildings, SC2 for all lifting beams, sculptures & fall arrest systems. Production category will be PC1 unless noted otherwise. All site welded items, S355 steelwork & CHS lattice girders will be PC2. As such the execution class for buildings will be EXC2.

11. CLIMATE CHANGE: The Building Research establishment have produced a document CBG 63 "Climate Change: impact on building design and construction". Part of their recommendations are that designers and builders should give consideration to:
    a. Increased wind loading by providing additional laps and fixings to roof coverings

    b. Consider foundation depth on shrinkable clays and to avoid future problems, increase the depth above standard requirements if there is a risk. This should be in accordance with the NHBC Standards, Chapter 4.2 Guidance on Building near Trees. If the calculations do not specifically design the depths of the foundations to take into account any local trees, then this should be checked and agreed with the Building Inspector on site.

Party Wall etc. Act 1996

If part of the work is adjacent to the boundary, the adjacent neighbours right to support could be affected; the issues associated with Party Wall Act may need to be considered. This may include providing information to the adjoining owner, giving sufficient notice of works in compliance with the Act. If the following list applies to this project then the Party Wall Act will apply. JMS Engineers can act as Party Wall Surveyors in this instance and should be contacted accordingly.

- Installing a new beam into the shared wall between properties
- Demolishing, building or under-pinning an existing shared wall
- Building a new wall at or on the boundary or junction of two properties
- Damp-proofing all the way through a party wall
- Digging foundations that are within 3m of a Party Wall, where the new foundations are deeper than the existing ones
- Where the new foundations are within 6m and lower than a 45° line from the bottom of the existing foundations

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JMS Underpinning Specification

1.Codes of Practice
All continuous underpinning is to be carried out strictly in accordance with the requirements of B.S.8004, 1985. The Code of Practice for Foundations. All materials used in the works shall comply with the relevant Codes of Practice.

2. Shoring and propping
It is the Contractor's responsibility to take all necessary steps to ensure that the structure is adequately propped, shored and braced to ensure that during the progress of the works excessive deflections and deformations of the structure do not occur. The Contractor shall discuss with the Engineer any proposals for temporary works. This does not in any way relieve the contractor of his responsibility to ensure that the structure is adequately supported at all times during the progress of the works. It is frequently necessary for the Contractor to brace of prop existing openings so that isolated load bearing piers may be underpinned. The Contracor is to allow in his tender price for all propping, shoring and bracing required to ensure that the works may be safely undertaken with no undue disruption to the structure.

3. Sequence of working
The sequence of working is to be submitted to the Engineer and approved by the Local Authority. This shall be based on a maximum leg length of approximately 1.2m. The agreed sequence of operations shall be strictly adhered to. The Contractor may wish to alter the excavation and concreting sequence but this must be discussed with the Engineer/Local Authority Representative, and no deviation from the sequence of operations shall be permitted unless the Engineer/Local Authority Representative confirms otherwise in writing.

4. Excavation and approval
During excavations the Contractor shall take all necessary steps to prevent softening of the excavation base by ground water. Where necessary the Contractor shall keep excavations free from ground water by pumping. The Contractor shall also ensure that the base of the excavation shall not become contaminated by loose material falling into the excavation. The Contractor shall take steps to ensure that the size of the excavation closely matches the required size agreed with the Engineer/Local Authority Representative. Excessive overbreak will not be permitted, and the Contractor shall provide all necessary trench sheeting and strutting to prevent overbreak. The Contractor may be required to provide sheeting and strutting to prevent any ingress of loose material beneath the existing slab. All underpinning excavations shall be approved by the Local Authority Representative before any concrete is placed.

5. Linking of adjacent legs
Prior to concreting the Contractor shall incorporate shear keys to permit shear transfer between adjacent underpinning legs. Where necessary projecting dowel bars should be cleaned of all loose dirt prior to concreting.

6. Cleaning of existing footings
The underside of all existing footings (where exposed by excavation in preparation for underpinning) shall be cleaned of all loose soil and fragments. Any major projections or inclusions such as bricks broken conrete or boulders shall be broken away from the underside of the existing footing. Prior to concreting the underpinning leg the existing footing should be clean firm and level so the dry packing may be accomplished satisfactorily.

7. Concreting
All concrete shall be strength grade C20 and mixed, delivered, placed and vibrated strictly in accordance with the concrete specification contained in B.S.8110:Part 1:1985. Sulphate resisting cement to be used should site conditions dictate or as directed by Local Building Control Officer. It should be noted that the concrete should be adequately compacted with a vibratory poker to ensure adequate density. The concrete for the underpinning legs should be brought up to 75mm from the underside of the existing footings.

8. Dry packing
Once the concrete in the underpinning legs has set (at least 3 days after concrete placement) the gap between the underside of the exisiting footing and the top of the new footing is to be packed with dry mortar. Mix proportions for the dry mortar are to be by weight 1:3 (cement:zone 2 sharp sand) with Combex non-shrink admixture added in accordance with Manufacturers recommendations. The constituents are to be mixed dry and a small volume of water is to be added such that when compressed, a small bar of the mixture retains its shape. The dry packing concrete is then to be rammed solid into the gap between the underside if the existing footing and the top of the new footing using a steel bar.

9. Curing time
A sufficient time should elapse between the completion of dry packing and the excavation of any underpinning legs in the vicinity. The curing time shall be 24 hours, this being dependent upon the prevailing weather conditions. Vicinity in this context shall be deemed to include all legs adjacent to, or next but one to the leg in question.

10. Provision for existing services
Underpinning legs may be punctured by the services entering the building. The means of "sleeving" these services shall be agreed with the Engineer during the progress of the works. Where existing services interfere with or affect the underpinning excavation these services should be temporarily diverted.

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Loading

Roof :	Tiles	=	0.65 kN/m²			Dead	Live
	Rafters, felt, insulation etc.	=	0.30 kN/m²				
			0.95 kN/m²/Cos 35	=	1.16 kN/m²		
	Plasterboard	=			0.25 kN/m²		
			TOTAL	**=**		**1.41 kN/m²**	
	Attic	=				0.25	
	Roof snow loading	=	0.6*((60-35)/30)	=		0.50 kN/m²	
			TOTAL	=			**0.75 kN/m²**
Roof :	Tiles	=	0.65 kN/m²			Dead	Live
	Plasterboard	=	0.25 kN/m²				
	Rafters, felt, insulation etc.	=	0.30 kN/m²				
			1.20 kN/m²/Cos 35	=	1.47 kN/m²		
			TOTAL	**=**		**1.47 kN/m²**	
	Attic	=				0.25	
	Roof snow loading	=	0.6*((60-35)/30)	=		0.50 kN/m²	
			TOTAL	=			**0.75 kN/m²**
Roof:	Joists &boarding, finishes	=	0.35 kN/m²				
(flat)	Plasterboard	=	0.25 kN/m²				
			TOTAL	**=**		**0.60 kN/m²**	
	Imposed	=	0.75 kN/m²				
			TOTAL	**=**			**0.75 kN/m²**
Floor:	PCU's	=	2.50 kN/m²				
	Screed	=	1.80 kN/m²				
	Plasterboard	=	0.25 kN/m²				
			TOTAL	**=**		**4.55 kN/m²**	
	Imposed loading	=				1.5	
	Partitions loading	=				1.0kN/m²	
			TOTAL	=			**2.5 kN/m²**
Floor:	Joists	=	0.15 kN/m²				
	Boarding	=	0.2 kN/m²				
	Plasterboard	=	0.25 kN/m²				
			TOTAL	**=**		**0.6 kN/m²**	
	Imposed loading	=				1.5	
	Partitions loading	=				0.5kN/m²	
			TOTAL	=			**2.0 kN/m²**
Walls:	2.4m high, 100mm blockwork	=	2.4*1.4	=	3.36 kN/m		
	Plasterwork both sides	=	2.4*0.25*2	=	1.2 kN/m		
			TOTAL	**=**		**4.56 kN/m**	
	2.4m high, 100mm brickwork	=	2.4*2.1	=	5.04 kN/m		
	Plasterwork both sides	=	2.4*0.25*2	=	1.2 kN/m		
			TOTAL	**=**		**6.24 kN/m**	
	2.4m high, studwork	=	2.4*0.12	=	0.29 kN/m		
	Plasterwork both sides	=	2.4*0.15*2	=	0.72 kN/m		
			TOTAL	**=**		**1.01 kN/m**	
	2.7m high, cavity wall blockwork	=	2.7*(2.1+1.4)	=	9.45 kN/m		
	Plasterwork to one side	=	2.4*0.25	=	0.60 kN/m		
			TOTAL	**=**		**10.05 kN/m**	
	2.7m high, solid brickwork	=	2.7*21*0.215	=	12.2 kN/m		
	Plasterwork to one side	=	2.4*0.25	=	0.60 kN/m		
			TOTAL	**=**		**12.8 kN/m**	
2.4m Bi-fold door:							
	(6mm float glass triple glazed)	**=**	2.4*0.75 kN/m²				
			TOTAL	**=**		**1.8 kN/m**	

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BASEMENT DESIGN PHILOSOPHY

The proposed basement is designed to take the vertical loads from the existing structure and the horizontal loads from the retained soils, surcharge and water through the new underpinning retaining walls which work together with the basement slab, supported on elastic soil.

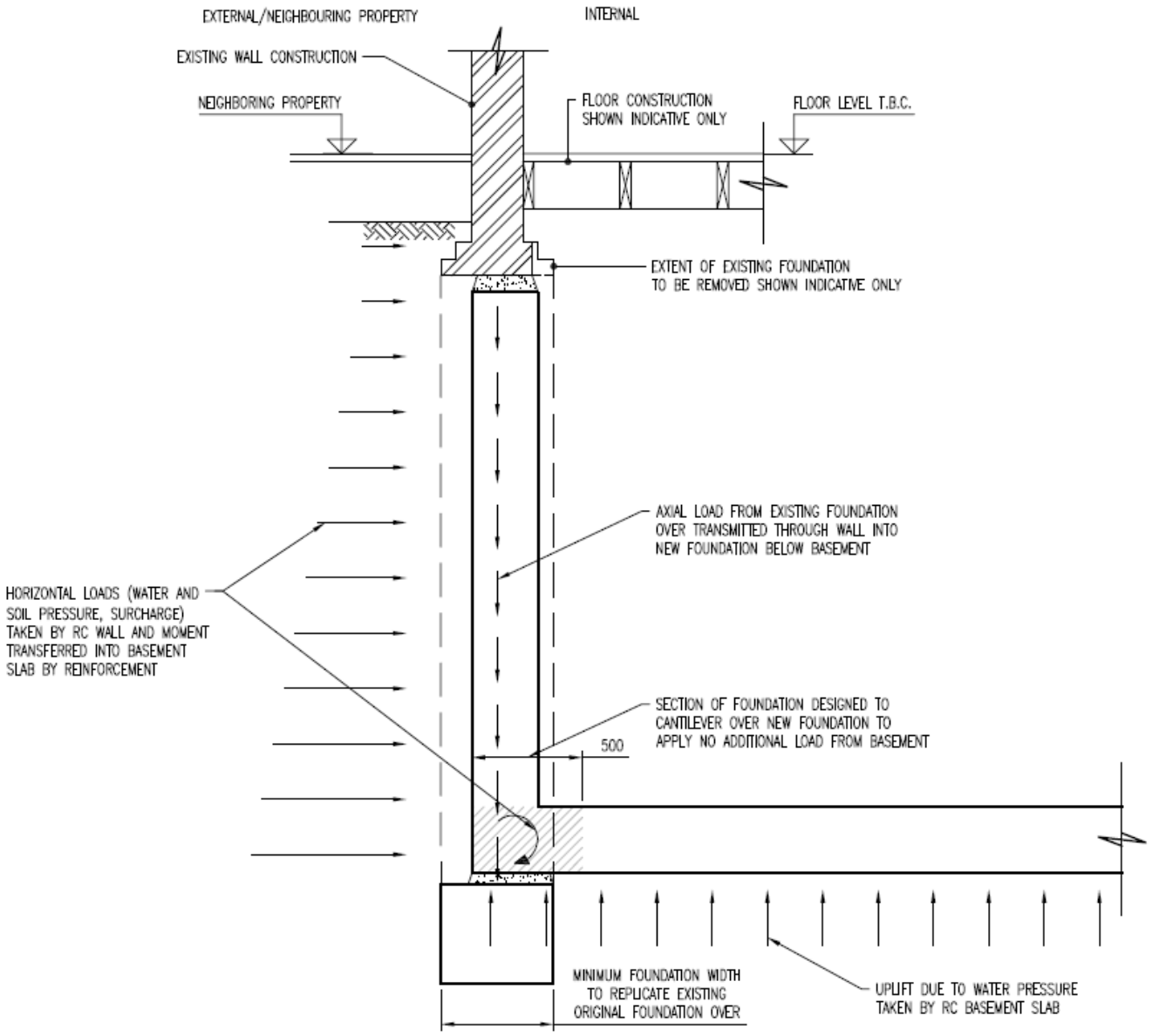

Figure 1: Basement Design Philosophy

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Parameters:

Materials	
Concrete	C30/37
Reinforcement	B500b
Projects Parameters	
H t (m) Retaining wall	2.70
L (m)	-
Soil Parameters	
γs (kN/m3)	20
ko	0.5
ka	0.33
Using ko, the earth pressures are considered 'at rest' Active pressure (ka) will be mobilised if the wall moves 0.25-1% of the wall height, while passive pressures (kp) will require movements of 2-4% in dense sand or 10-15% in loose sand Typical ko values: 0.50-0.60 for normally consolidated clay, 0.35 for dense sand, 0.6 for loose sand 1.0-2.8 for overconsolidated clays such as London clay. *(source: Structural Engineer's Pocket Book, Eurocodes by Fionna Cobb, page 336)*	
GBP (kN/m2)	100
Water Parameters	
γw (kN/m3)	10
Load Parameters	
Dead surcharge load from adjacent building or road Ds (kN/m2)	10
Live surcharge load from adjacent building or road Ls (kN/m2)	20/10
Dead load from superstructure Dsp (kN/m)	67.47 (max)
Live load from superstructure Lsp (kN/m)	21.00 (max)
Live load on slab (kN/m2)	1.5

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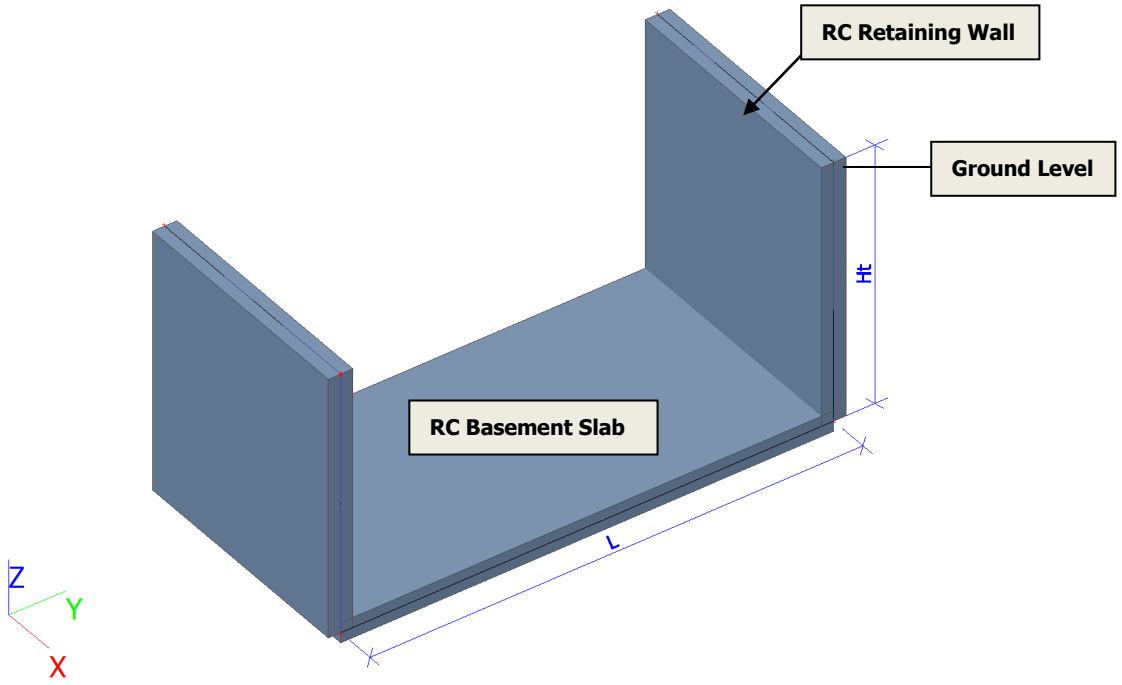

Figure 2: Section of the Basement

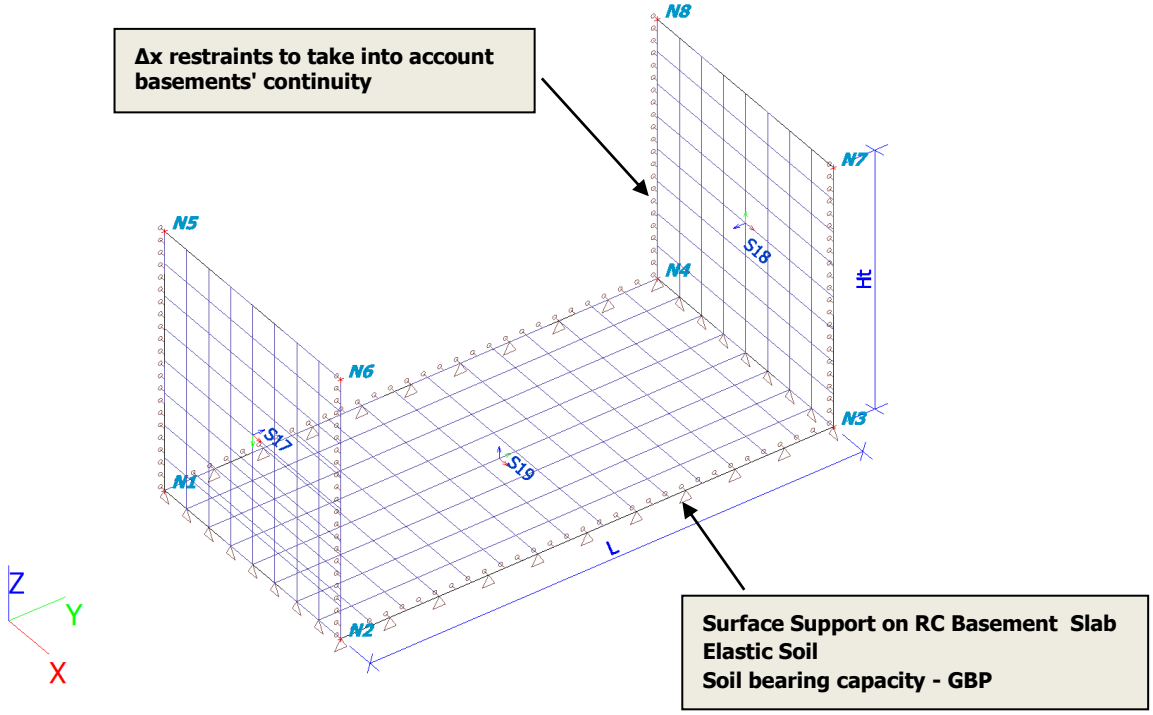

Figure 3: Analysis model

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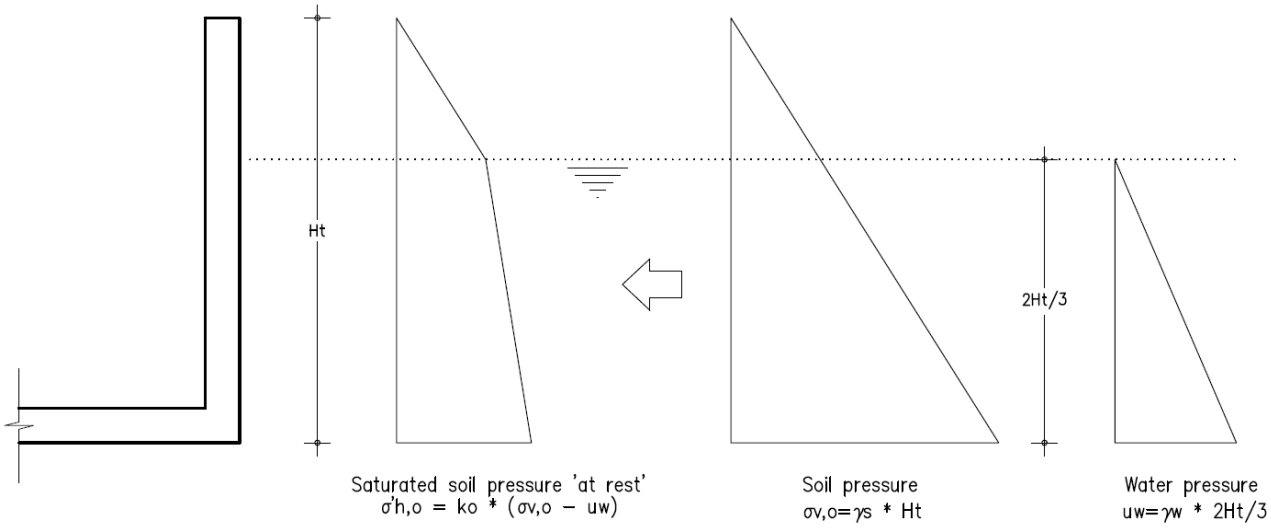

Total pressure at wall: $P = \sigma'_{h,o} + uw =$

$= ko*(\sigma_{v,o} - uw) + uw$

$= ko*\sigma_{v,o} + (1-ko)*uw$

$= ko*\gamma s*Ht + (1-ko)*\gamma w*2Ht/3$

Figure 4: Soil and HydroStatic Pressure at wall

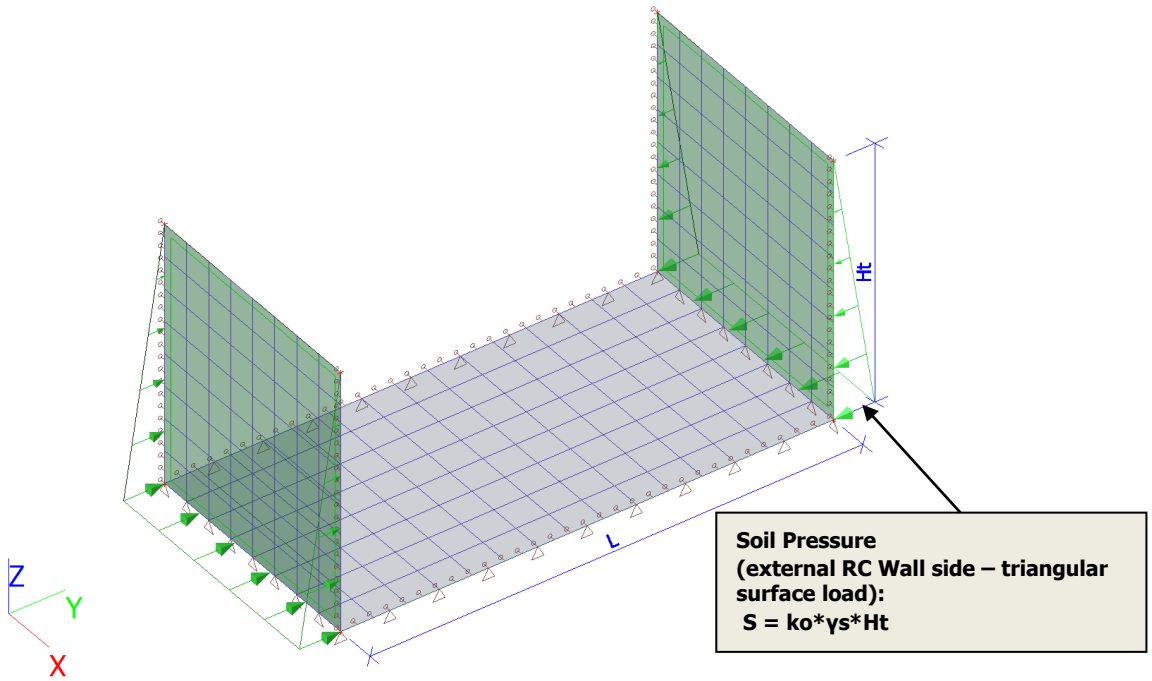

Figure 4a: Soil Pressure

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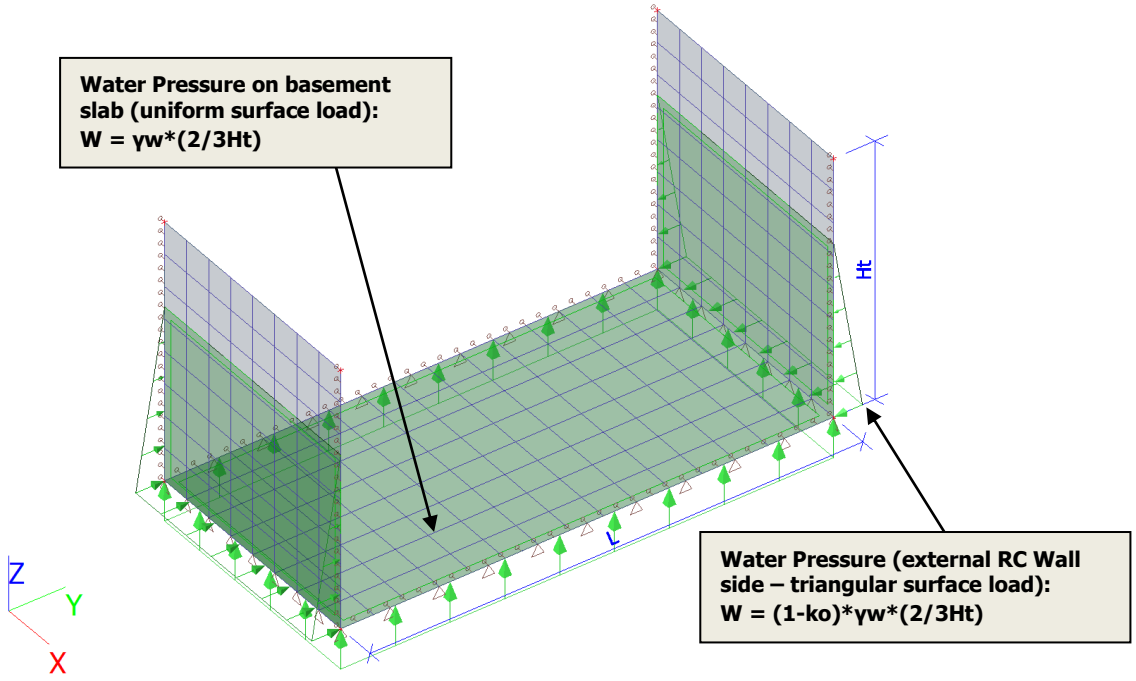

Figure 4b: Water Pressure
Pressumed to apply to the 2/3 of the depth of the basement

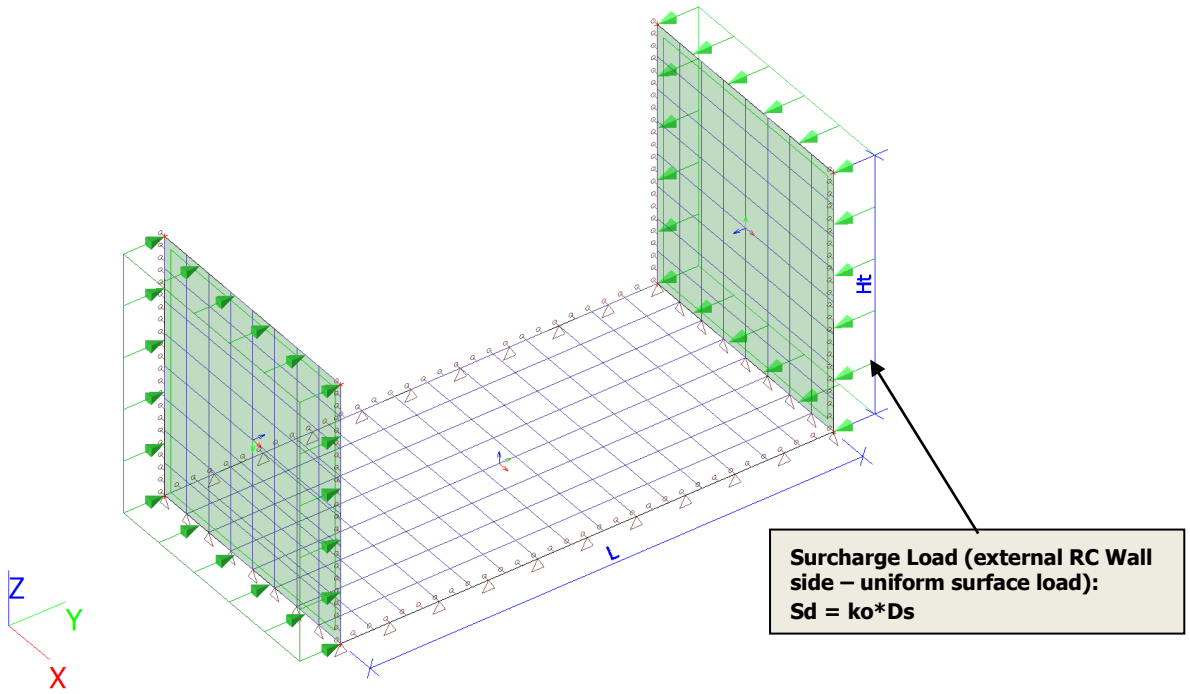

Figure 5: Dead surcharge load from adjacent building or road

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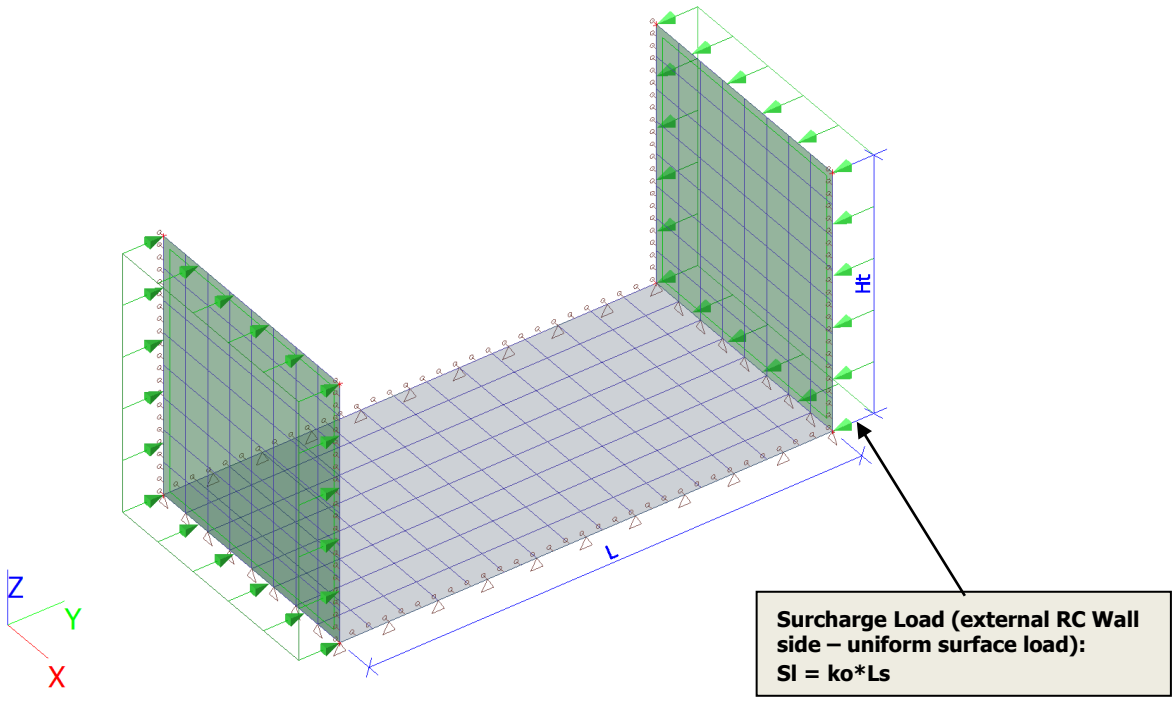

Figure 6: Live surcharge load from adjacent building or road

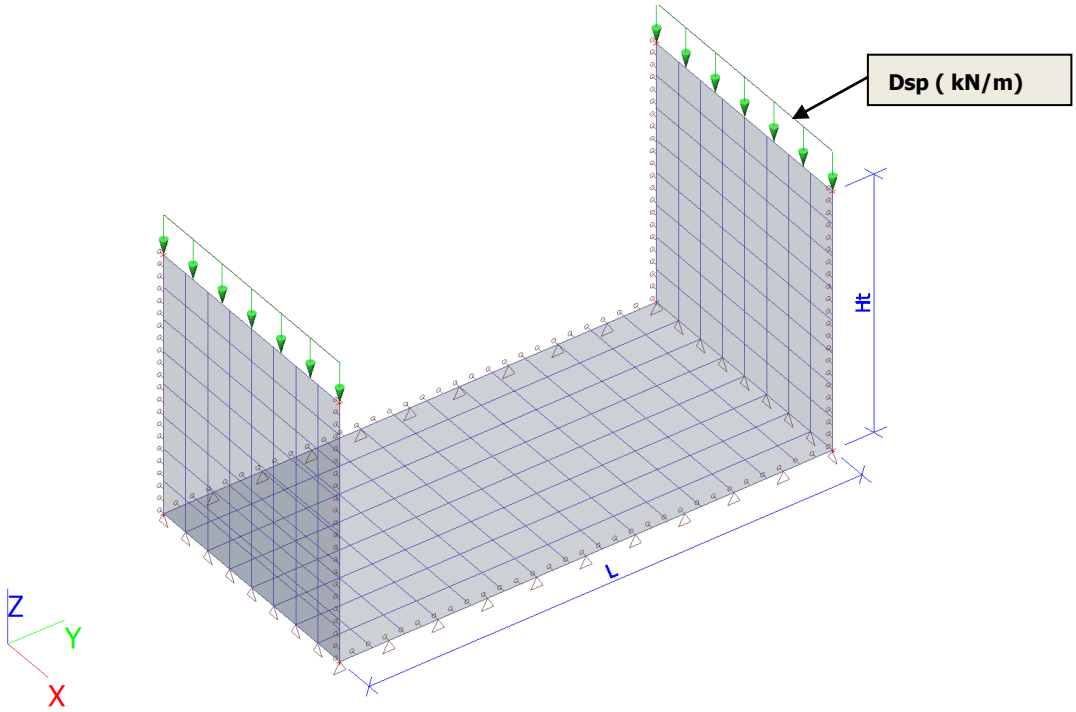

Figure 7: Dead Load from superstructure

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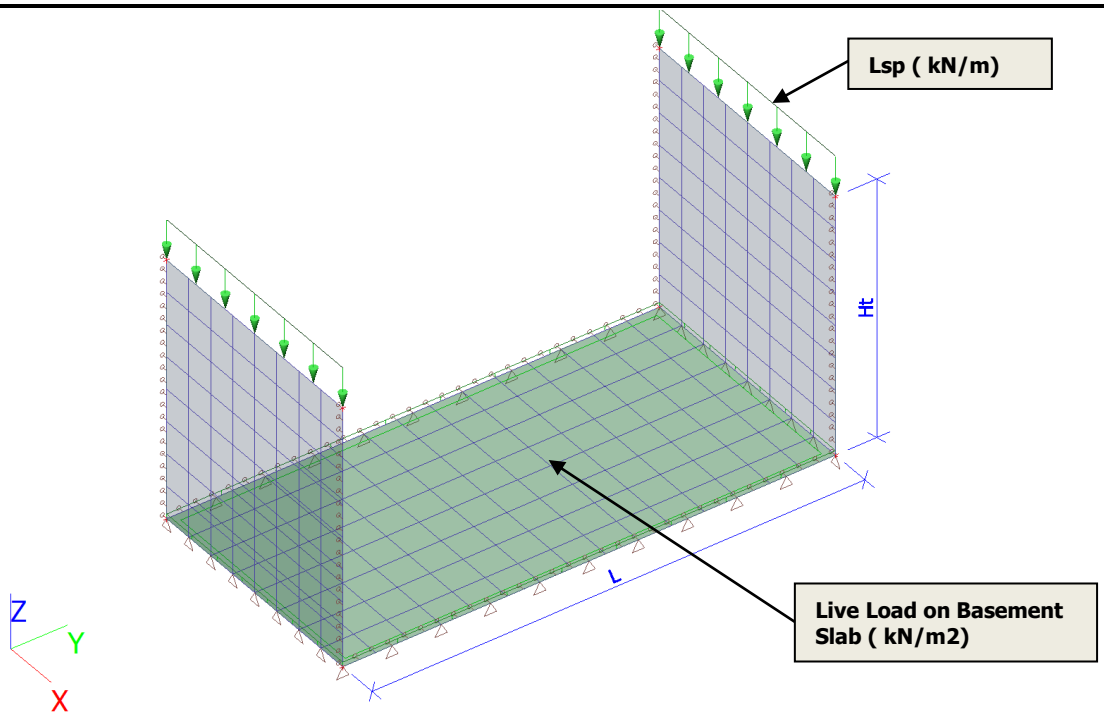

Figure 8: Live Load from superstructure

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The design takes into consideration the following load cases:

Name	Description	Action type
LC1	Self-Weight	Permanent
LC2	Soil Pressure	Permanent
LC3	Water Pressure	Variable
LC4	Surcharge (D)	Permanent
LC5	Surcharge (L)	Variable
LC6	Dead (superstructure)	Permanent
LC7	Live (Superstructure)	Variable

The load cases are combined according to the **EN 1990** combination setup:

ψ factors

Load	ψ0	ψ1	ψ2
CategoryA	0.7	0.5	0.3

Load combination factors

Permanent action - unfavorable	1.35
Permanent action - favorable	1.00
Leading variable action	1.50
Accompanying variable action	1.50
Reduction factor ksi	0.85
Permanent action - unfavorable	1.00
Permanent action - favorable	1.00
Leading variable action	1.30
Accompanying variable action	1.30

EN - ULS (STR/GEO) Set B combinations:

Name	Description	Type	Load cases	Coeff. [-]
ULS1		Linear - ultimate	LC1 - Self-Weight	1.35
			LC2 - Soil Pressure	1.35
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS2		Linear - ultimate	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
ULS3		Linear - ultimate	LC1 - Self-Weight	1.35
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.35
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS4		Linear - ultimate	LC1 - Self-Weight	1.35
			LC2 - Soil Pressure	1.35

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Name	Description	Type	Load cases	Coeff. [-]
			LC3 - Water Pressure	1.50
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS5		Linear - ultimate	LC1 - Self-Weight	1.35
			LC2 - Soil Pressure	1.35
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS6		Linear - ultimate	LC1 - Self-Weight	1.35
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.35
			LC3 - Water Pressure	1.50
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS7		Linear - ultimate	LC1 - Self-Weight	1.35
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.35
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS8		Linear - ultimate	LC1 - Self-Weight	1.35
			LC2 - Soil Pressure	1.35
			LC3 - Water Pressure	1.50
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS9		Linear - ultimate	LC1 - Self-Weight	1.35
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.35
			LC3 - Water Pressure	1.50
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.35
			LC6 - Dead (superstructure)	1.35
ULS10		Linear - ultimate	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
ULS11		Linear - ultimate	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
ULS12		Linear - ultimate	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
ULS13		Linear - ultimate	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
ULS14		Linear - ultimate	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00

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Name	Description	Type	Load cases	Coeff. [-]
ULS15		Linear - ultimate	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.50
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
ULS16		Linear - ultimate	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.50
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.50
			LC5 - Surcharge (L)	1.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00

EN- SLS Characteristic, Frequent, Quasi-Permanent combinations:

Name	Description	Type	Load cases	Coeff. [-]
SLS-Ch1		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Ch2		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.00
			LC2 - Soil Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Ch3		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Ch4		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Ch5		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Ch6		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.00
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Ch7		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00
			LC5 - Surcharge (L)	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Ch8		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00

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			LC5 - Surcharge (L)	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Fr1		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.50
			LC2 - Soil Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Fr2		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	0.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Fr3		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	0.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Fr4		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.50
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	0.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Fr5		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.50
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	0.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Fr6		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	0.50
			LC5 - Surcharge (L)	0.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Fr7		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.50
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	0.50
			LC5 - Surcharge (L)	0.50
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Qp1		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.30
			LC2 - Soil Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Qp2		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	0.30
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Qp3		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	0.30
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Qp4		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.30
			LC2 - Soil Pressure	1.00

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			LC3 - Water Pressure	0.30
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Qp5		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.30
			LC2 - Soil Pressure	1.00
			LC5 - Surcharge (L)	0.30
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Qp6		Linear - serviceability	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	0.30
			LC5 - Surcharge (L)	0.30
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00
SLS-Qp7		Linear - serviceability	LC1 - Self-Weight	1.00
			LC7 - Live (Superstructure)	0.30
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	0.30
			LC5 - Surcharge (L)	0.30
			LC4 - Surcharge (D)	1.00
			LC6 - Dead (superstructure)	1.00

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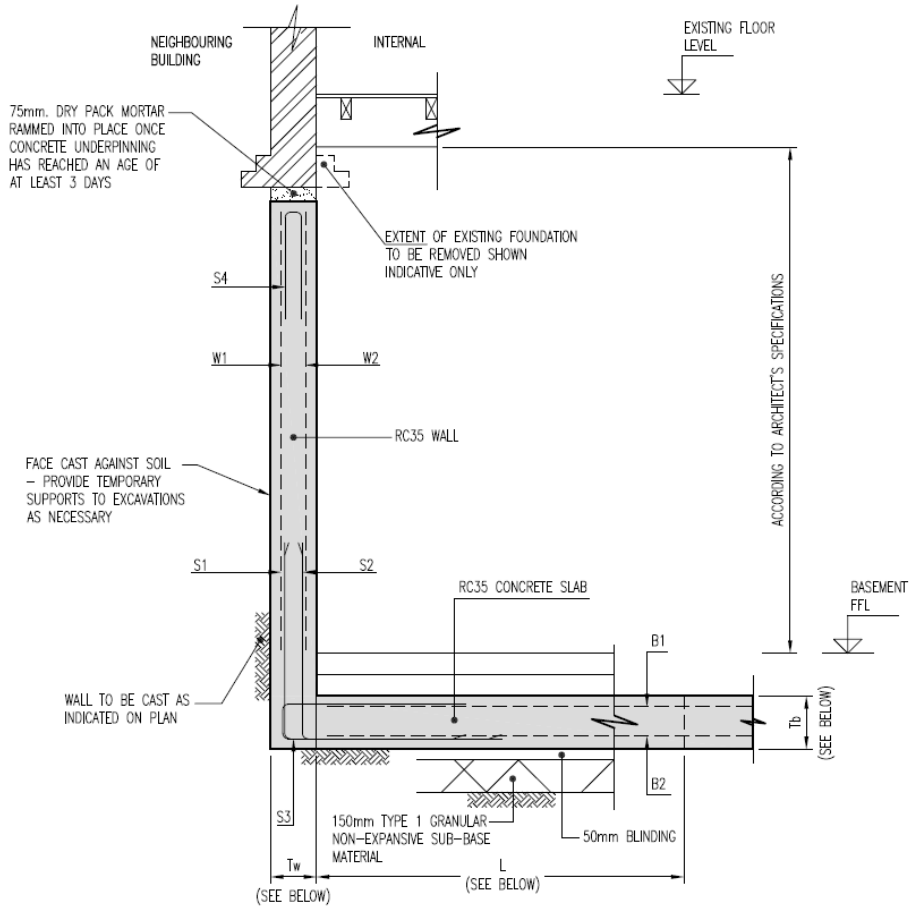
Results:



Geometry	
Tb - Base thickness (mm)	**250**
Tw - Wall thickness (mm) Retaining wall	**300**
L (mm)	**-**
Reinforcement – Basement Base bars	
B1 (top)	**2 Layers A393 Mesh (staggered)**
B2 (bottom)	**1 Layer A393 Mesh**
Reinforcement – Retaining Wall bars	
W1 (outer face)	**H12-200 each way**
W2 (inner face)	**H12-200 each way**
Reinforcement - Starter bars	
S1 (wall outer face)	**H16-200 L-bars**
S2 (wall inner face)	**H16-200 L-bars**
S3 (base edge)	**H12-200 U-bars**
S4 (wall top)	**H12-200 U-bars**

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APPENDIX A

BASEMENT CALCULATIONS

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8. Design
8.1. Member 2D - design - required areas; As1- (ULS) Basement Slab Bottom - x, Walls Outer Face - x
8.2. Member 2D - design - required areas; As2- (ULS) - Basement Slab Bottom - y, Walls Outer Face - y
8.3. Member 2D - design - required areas; As1+ (ULS) Basement Slab Top - x, Walls Inner Face - x
8.4. Member 2D - design - required areas; As2+ (ULS) Basement Slab Top - y, Walls Inner Face - y

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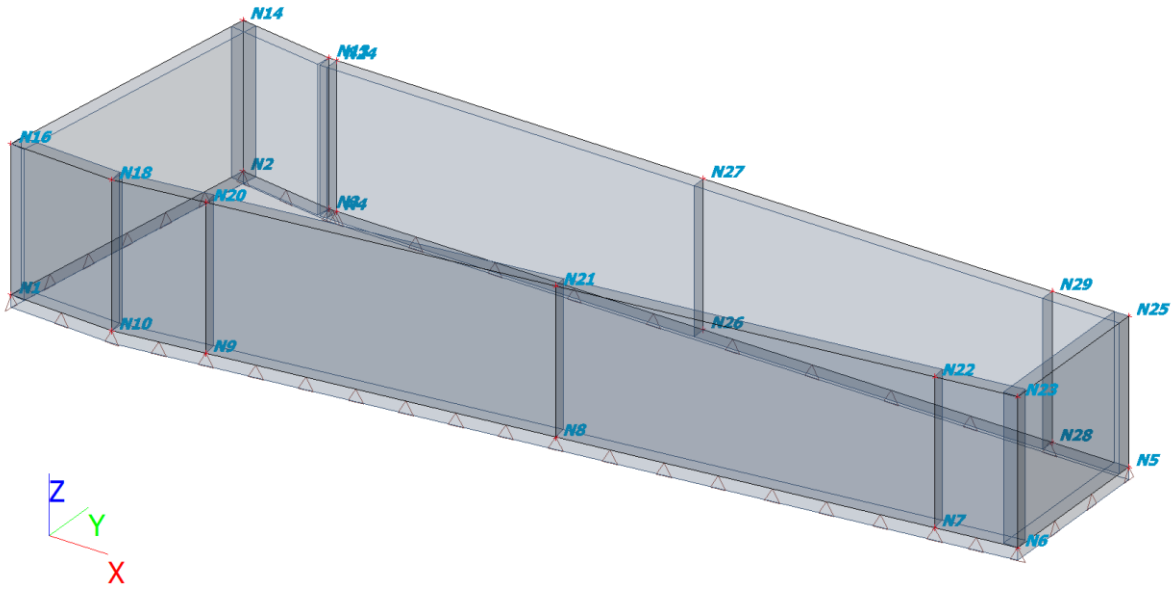
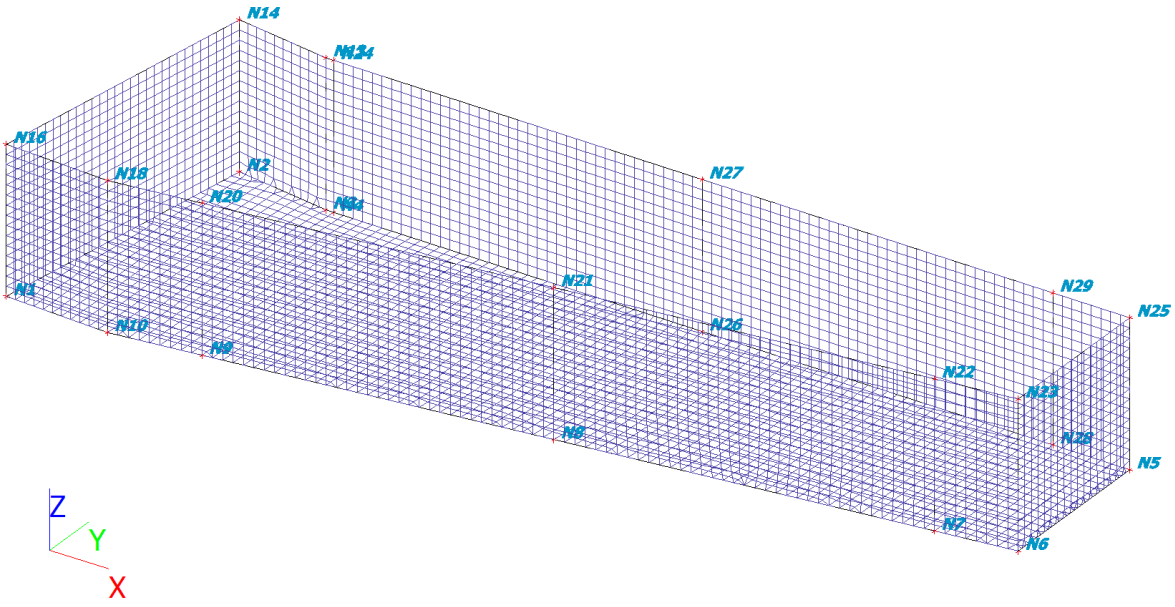
2. Model

2.1. Typical Basement Section



2.2. Analysis model



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3. Libraries

3.1. Setup manager

Combination setup

Annex - Category H loading not to be combined with snow or wind	
Category H loading not to be combined with snow or wind	Yes

Psi factors

Load	Psi0	Psi1	Psi2
CategoryA	0.7	0.5	0.3
CategoryB	0.7	0.5	0.3
CategoryC	0.7	0.7	0.6
CategoryD	0.7	0.7	0.6
CategoryE	1	0.9	0.8
CategoryF	0.7	0.7	0.6
CategoryG	0.7	0.5	0.3
CategoryH	0	0	0
Snow	0.5	0.2	0
Wind	0.6	0.2	0
Temperature	0.6	0.5	0

Load combination factors

Permanent action - unfavorable	1.35
Permanent action - favorable	1.00
Leading variable action	1.50
Accompanying variable action	1.50
Reduction factor ksi	0.85
Permanent action - unfavorable	1.00
Permanent action - favorable	1.00
Leading variable action	1.30
Accompanying variable action	1.30

3.2. Materials

Concrete EC2

Name	Type	Unit mass [kg/m^3]	E mod [kN/m^2]	Poisson - nu	Thermal exp [m/mK]	Characteristic compressive cylinder strength fck(28) [MPa]
C30/37	Concrete	2500.0	32800000.0	0.2	0.00	30.00

Reinforcement EC2

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Name	Type	Unit mass [kg/m³]	E mod [kN/m²]	G mod [kN/m²]	Thermal exp [m/mK]	Characteristic yield strength fyk [MPa]
B 500B	Reinforcement steel	7850.0	200000000.0	83333333.3	0.00	500.0

3.3. Subsoils

Name	C1x [kN/m³]	C1z	C1y [kN/m³]	Stiffness [kN/m³]	C2x [kN/m]	C2y [kN/m]	Sigma oc [kN/m²]
Sub1	1000.0	Flexible	1000.0	10000.0	1000.0	1000.0	100.0

4. Structure

4.1. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	0.889	5.918	0.000
N3	2.882	5.619	0.000
N4	3.039	5.619	0.000
N5	19.555	5.619	0.000
N6	19.555	2.147	0.000
N7	17.958	1.941	0.000
N8	10.687	1.001	0.000
N9	3.972	0.131	0.000
N10	2.164	-0.104	0.000
N13	2.882	5.619	3.000
N14	0.889	5.918	3.000
N16	0.000	0.000	3.000
N18	2.164	-0.104	3.000
N20	3.972	0.131	3.000
N21	10.687	1.001	3.000
N22	17.958	1.941	3.000
N23	19.555	2.147	3.000
N24	3.039	5.619	3.000
N25	19.555	5.619	3.000
N26	10.687	5.619	0.000
N27	10.687	5.619	3.000
N28	17.958	5.619	0.000
N29	17.958	5.619	3.000

4.2. 2D members

Name	Layer	Type	Analysis model	Material	Thickness type	Th. [mm]	
S1	Layer2-Concrete Slabs	plate (90)	Standard	C30/37	constant	250	
S2	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S3	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S4	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S5	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S6	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S7	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S8	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S9	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S11	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S12	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S13	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	
S14	Layer3-Concrete Wall	wall (80)	Standard	C30/37	constant	300	

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4.3. 2D member supports

Name	Type	Subsoil	2D member
SS1	Individual	Sub1 - 100 KN/m2	S1

5. Sets

5.1. Load cases

Name	Description	Action type	LoadGroup	Direction	Duration	Master load case
	Spec	Load type				
LC1	Self-Weight	Permanent	LG1-D	-Z		
		Self weight				
LC2	Soil Pressure	Permanent	LG1-D			
		Standard				
LC3	Water Pressure	Variable	LG2-L		Short	None
	Standard	Static				
LC4	Surcharge (D)	Permanent	LG1-D			
		Standard				
LC5	Surcharge (L)	Variable	LG2-L		Short	None
	Standard	Static				
LC6	Dead (superstructure)	Permanent	LG1-D			
		Standard				
LC7	Live (Superstructure)	Variable	LG2-L		Short	None
	Standard	Static				

5.2. Load groups

Name	Load	Relation	Type
LG1-D	Permanent		
LG2-L	Variable	Standard	Cat A : Domestic

5.3. Combinations

Name	Description	Type	Load cases	Coeff. [-]
ULS		EN-ULS (STR/GEO) Set B	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC5 - Surcharge (L)	1.00
			LC6 - Dead (superstructure)	1.00
			LC7 - Live (Superstructure)	1.00
SLS-Ch		EN-SLS Characteristic	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC5 - Surcharge (L)	1.00
			LC6 - Dead (superstructure)	1.00
			LC7 - Live (Superstructure)	1.00
SLS-Fr		EN-SLS Frequent	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00
			LC4 - Surcharge (D)	1.00
			LC5 - Surcharge (L)	1.00
			LC6 - Dead (superstructure)	1.00
			LC7 - Live (Superstructure)	1.00
SLS-Qp		EN-SLS Quasi-permanent	LC1 - Self-Weight	1.00
			LC2 - Soil Pressure	1.00
			LC3 - Water Pressure	1.00
			LC4 - Surcharge (D)	1.00

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Name	Description	Type	Load cases	Coeff. [-]
			LC5 - Surcharge (L)	1.00
			LC6 - Dead (superstructure)	1.00
			LC7 - Live (Superstructure)	1.00

5.4. Result classes

Name	List
SLS	SLS-Ch - EN-SLS Characteristic
	SLS-Fr - EN-SLS Frequent
	SLS-Qp - EN-SLS Quasi-permanent
GEO	ULS - EN-ULS (STR/GEO) Set B

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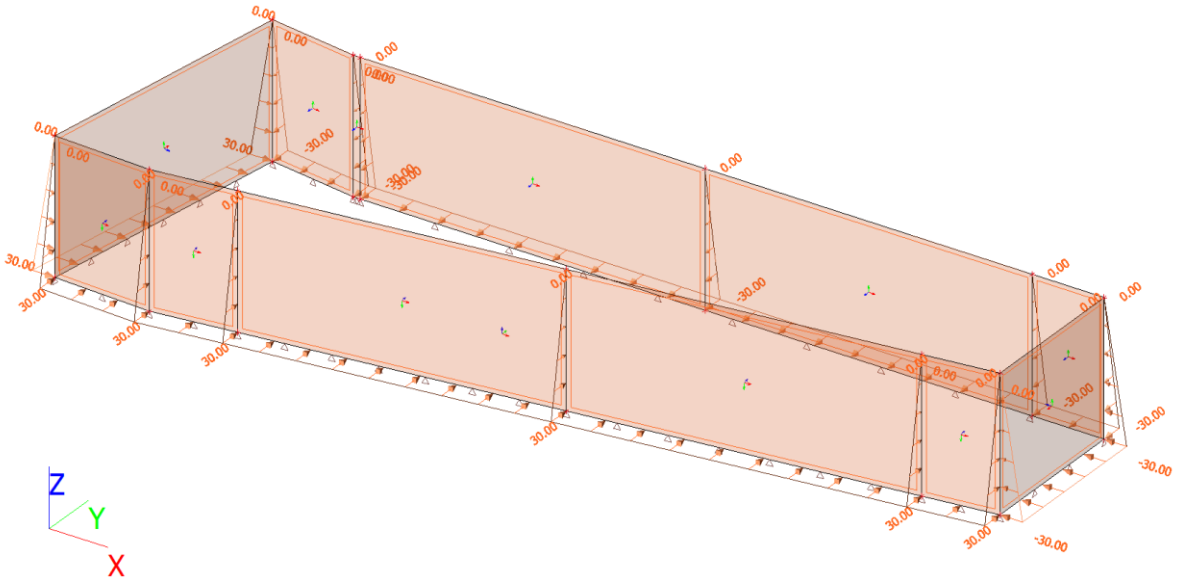
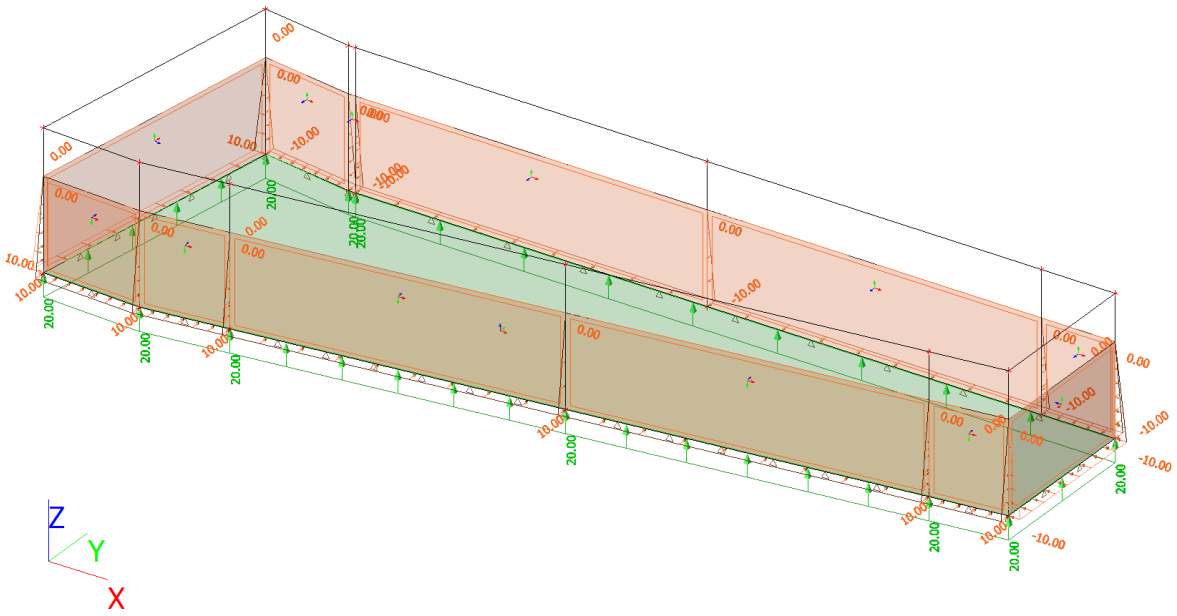
6. Loads

6.1. LC2 - Soil pressure = ko*γs*Ht



6.2. LC3 - Water Pressure = (1-ko)*γw*(2/3Ht) at walls, γw*(2/3Ht) at base



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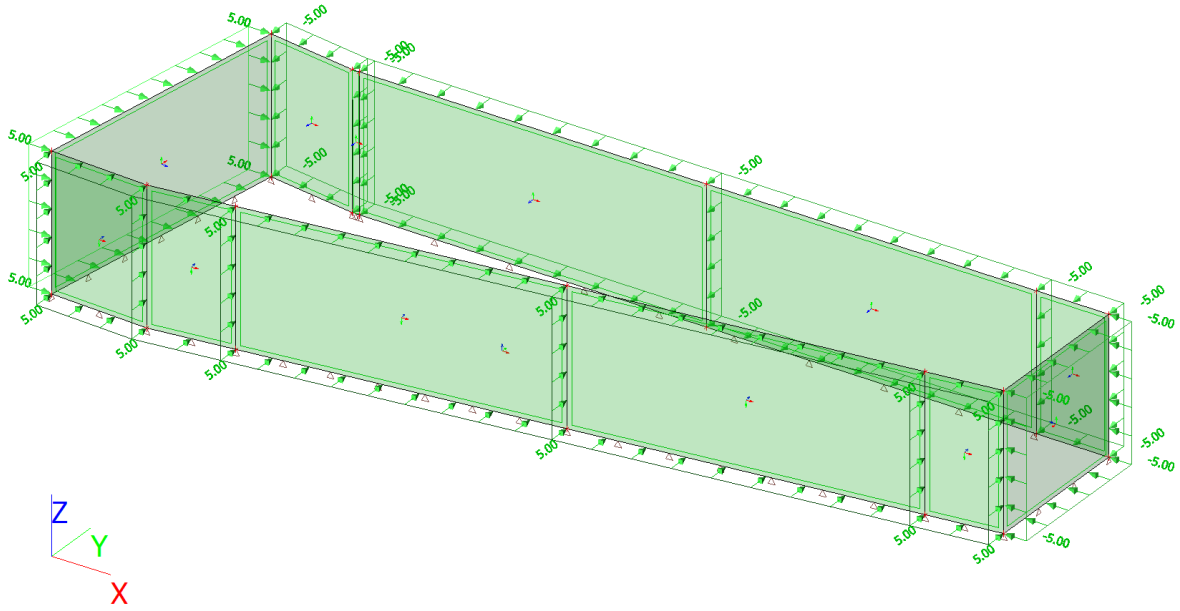
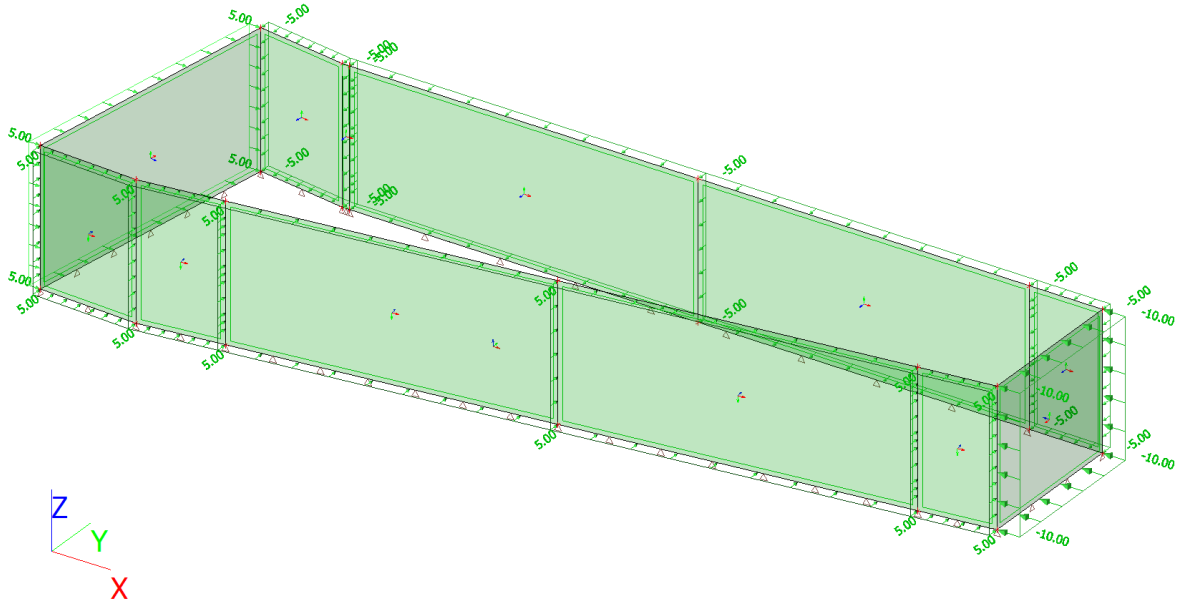
6.3. LC4 - Surcharge Dead = ko*D



6.4. LC5 - Surcharge Live = ko*L



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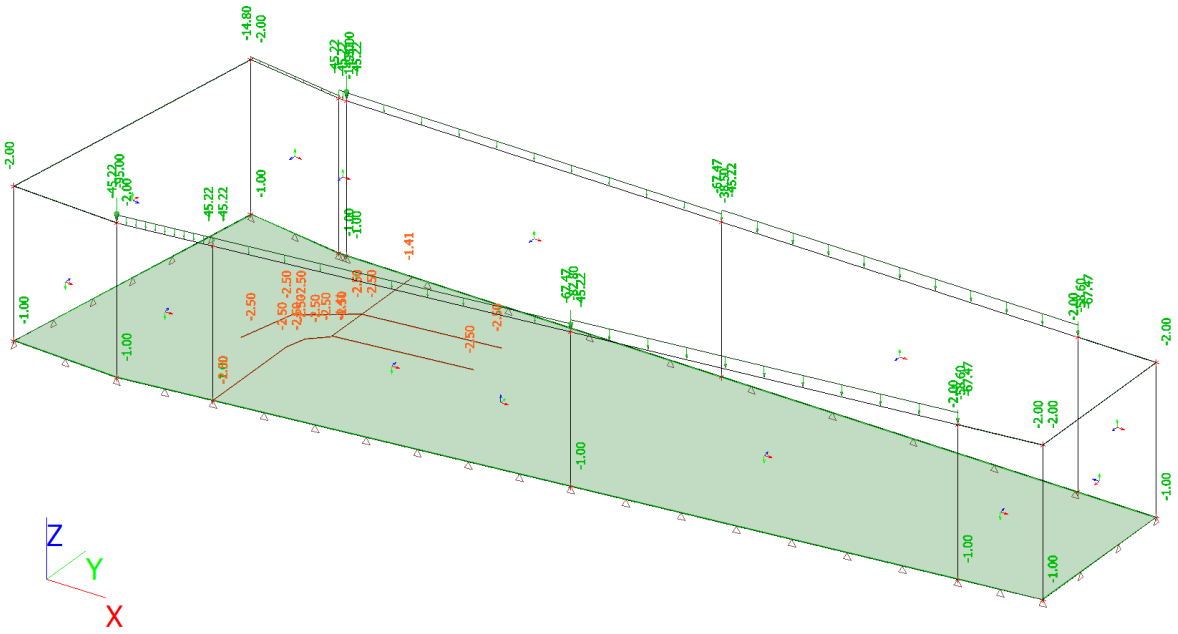
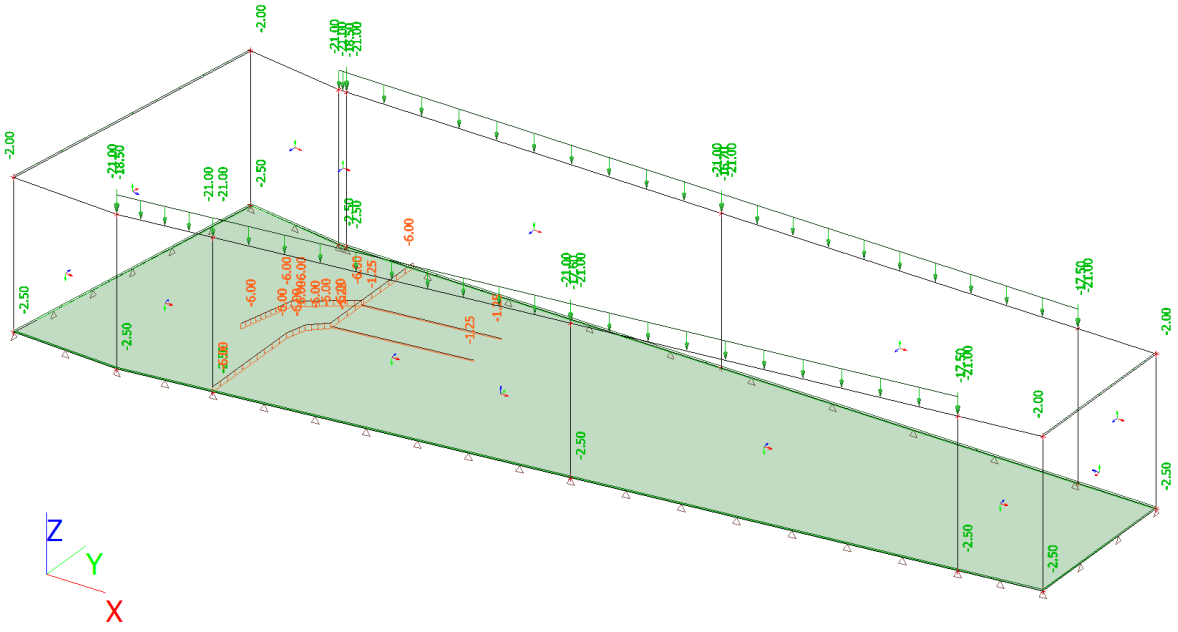
6.5. LC6 - Dead (from superstructure)



6.6. LC7 - Live (from superstructure)



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6.7. Line force on 2D member edge

Name	2D member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Loc	Edge
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Coor	Orig
LFS1	S13	Force	Z	-67.47	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS2	S7	Force	Z	-67.47	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS3	S6	Force	Z	-45.22	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS4	S12	Force	Z	-45.22	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS5	S7	Force	Z	-21.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start
LFS6	S13	Force	Z	-21.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start
LFS7	S12	Force	Z	-21.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start
LFS8	S6	Force	Z	-21.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start
LFS9	S5	Force	Z	-21.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start
LFS10	S5	Force	Z	-45.22	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS11	S9	Force	Z	-45.22	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS12	S9	Force	Z	-21.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start
LFS13	S2	Force	Z	-14.80	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS14	S4	Force	Z	-2.00	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS15	S3	Force	Z	-2.00	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS16	S8	Force	Z	-2.00	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS17	S11	Force	Z	-2.00	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS18	S14	Force	Z	-2.00	0.000	Length	3
	LC6 - Dead (superstructure)	GCS	Uniform		1.000	Rela	From start
LFS19	S11	Force	Z	-2.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start
LFS20	S3	Force	Z	-2.00	0.000	Length	3
	LC7 - Live (Superstructure)	GCS	Uniform		1.000	Rela	From start

6.8. Surface load

Name	Dir	Type	Value [kN/m²]	2D member	Load case	System	Loc
SF1	Z	Force	20.00	S1	LC3 - Water Pressure	GCS	Length
SF2	Y	Force	-5.00	S13	LC4 - Surcharge (D)	GCS	Length
SF3	Y	Force	-5.00	S12	LC4 - Surcharge (D)	GCS	Length
SF4	Y	Force	-5.00	S14	LC4 - Surcharge (D)	GCS	Length
SF5	Y	Force	-5.00	S2	LC4 - Surcharge (D)	GCS	Length
SF6	Y	Force	-5.00	S9	LC4 - Surcharge (D)	GCS	Length
SF7	X	Force	-5.00	S11	LC4 - Surcharge (D)	GCS	Length
SF8	X	Force	5.00	S3	LC4 - Surcharge (D)	GCS	Length
SF9	Y	Force	5.00	S5	LC4 - Surcharge (D)	GCS	Length
SF10	Y	Force	5.00	S6	LC4 - Surcharge (D)	GCS	Length

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Name	Dir	Type	Value [kN/m²]	2D member	Load case	System	Loc
SF11	Y	Force	5.00	S7	LC4 - Surcharge (D)	GCS	Length
SF12	Y	Force	5.00	S8	LC4 - Surcharge (D)	GCS	Length
SF13	Y	Force	5.00	S4	LC4 - Surcharge (D)	GCS	Length
SF14	Y	Force	-5.00	S13	LC5 - Surcharge (L)	GCS	Length
SF15	Y	Force	-5.00	S12	LC5 - Surcharge (L)	GCS	Length
SF16	Y	Force	-5.00	S14	LC5 - Surcharge (L)	GCS	Length
SF17	Y	Force	-5.00	S2	LC5 - Surcharge (L)	GCS	Length
SF18	Y	Force	-5.00	S9	LC5 - Surcharge (L)	GCS	Length
SF19	X	Force	-10.00	S11	LC5 - Surcharge (L)	GCS	Length
SF20	X	Force	5.00	S3	LC5 - Surcharge (L)	GCS	Length
SF21	Y	Force	5.00	S5	LC5 - Surcharge (L)	GCS	Length
SF22	Y	Force	5.00	S6	LC5 - Surcharge (L)	GCS	Length
SF23	Y	Force	5.00	S7	LC5 - Surcharge (L)	GCS	Length
SF24	Y	Force	5.00	S8	LC5 - Surcharge (L)	GCS	Length
SF25	Y	Force	5.00	S4	LC5 - Surcharge (L)	GCS	Length
SF26	Z	Force	-2.50	S1	LC7 - Live (Superstructure)	GCS	Length
SF27	Z	Force	-1.00	S1	LC6 - Dead (superstructure)	GCS	Length

6.9. Free surface load

Name	Load case	Dir	Type	Distribution	q1 [kN/m²]	q2 [kN/m²]	q3 [kN/m²]	Validity	Select	System	Location
FF1	LC2 - Soil Pressure	X	Force	3 points	30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF3	LC2 - Soil Pressure	Y	Force	3 points	30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF4	LC2 - Soil Pressure	Y	Force	3 points	30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF5	LC2 - Soil Pressure	Y	Force	3 points	30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF6	LC2 - Soil Pressure	Y	Force	3 points	30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF7	LC2 - Soil Pressure	Y	Force	3 points	30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF8	LC2 - Soil Pressure	X	Force	3 points	-30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF10	LC2 - Soil Pressure	Y	Force	3 points	-30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF11	LC2 - Soil Pressure	Y	Force	3 points	-30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF12	LC2 - Soil Pressure	Y	Force	3 points	-30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF13	LC2 - Soil Pressure	Y	Force	3 points	-30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF14	LC2 - Soil Pressure	Y	Force	3 points	-30.00	0.00	0.00	Z=0	Auto	GCS	Length
FF15	LC3 - Water Pressure	X	Force	3 points	10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF16	LC3 - Water Pressure	Y	Force	3 points	10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF17	LC3 - Water Pressure	Y	Force	3 points	10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF18	LC3 - Water Pressure	Y	Force	3 points	10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF19	LC3 - Water Pressure	Y	Force	3 points	10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF20	LC3 - Water Pressure	Y	Force	3 points	10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF21	LC3 - Water Pressure	X	Force	3 points	-10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF22	LC3 - Water Pressure	Y	Force	3 points	-10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF23	LC3 - Water Pressure	Y	Force	3 points	-10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF24	LC3 - Water Pressure	Y	Force	3 points	-10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF25	LC3 - Water Pressure	Y	Force	3 points	-10.00	0.00	0.00	Z=0	Auto	GCS	Length
FF26	LC3 - Water Pressure	Y	Force	3 points	-10.00	0.00	0.00	Z=0	Auto	GCS	Length

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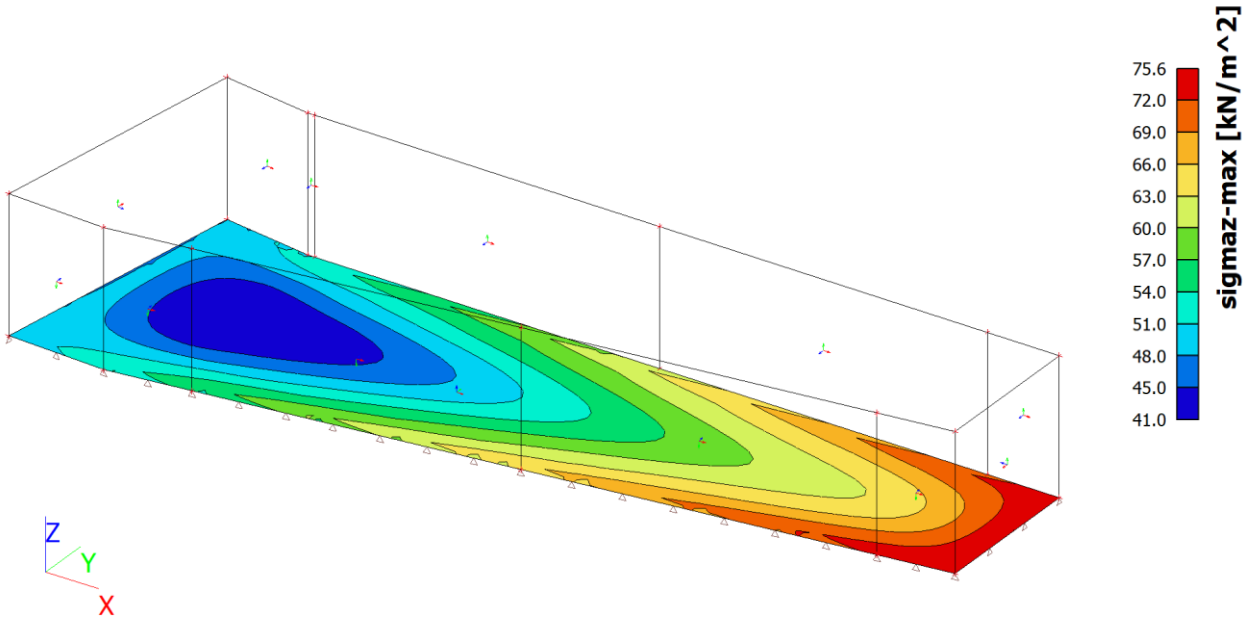
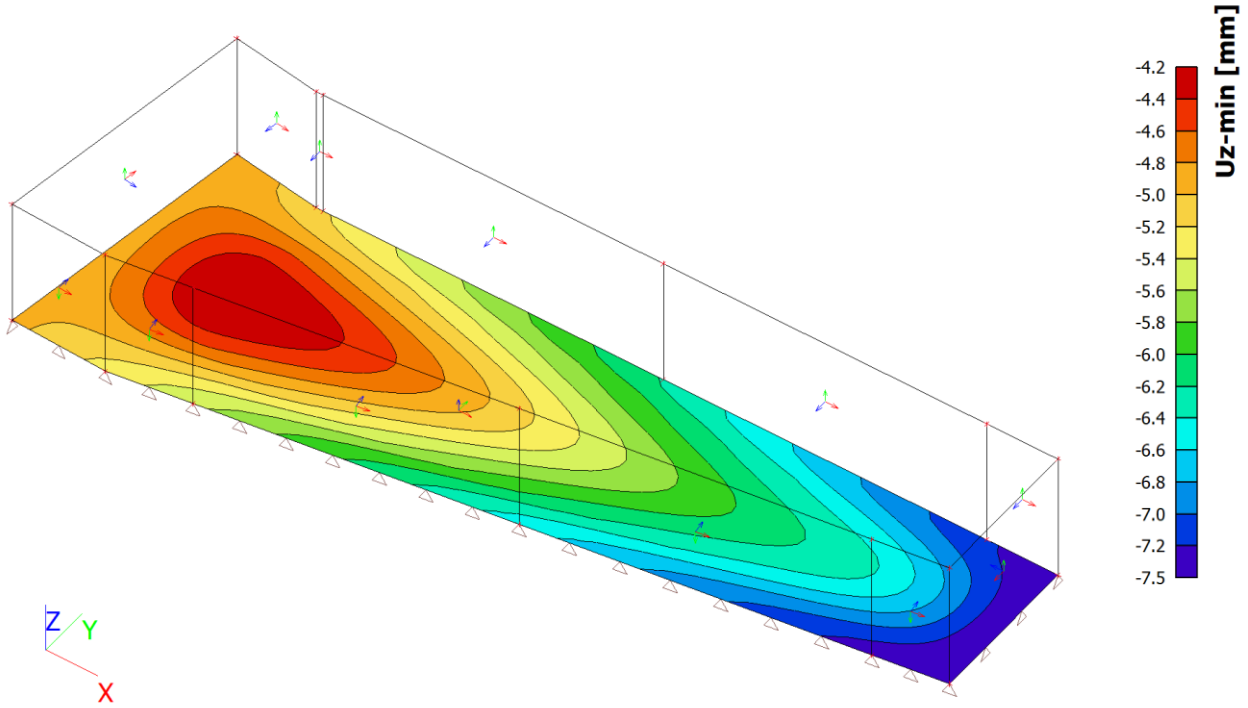
7. Results

7.1. Contact stresses; sigmaz



7.2. Displacement of nodes; Uz (SLS) min



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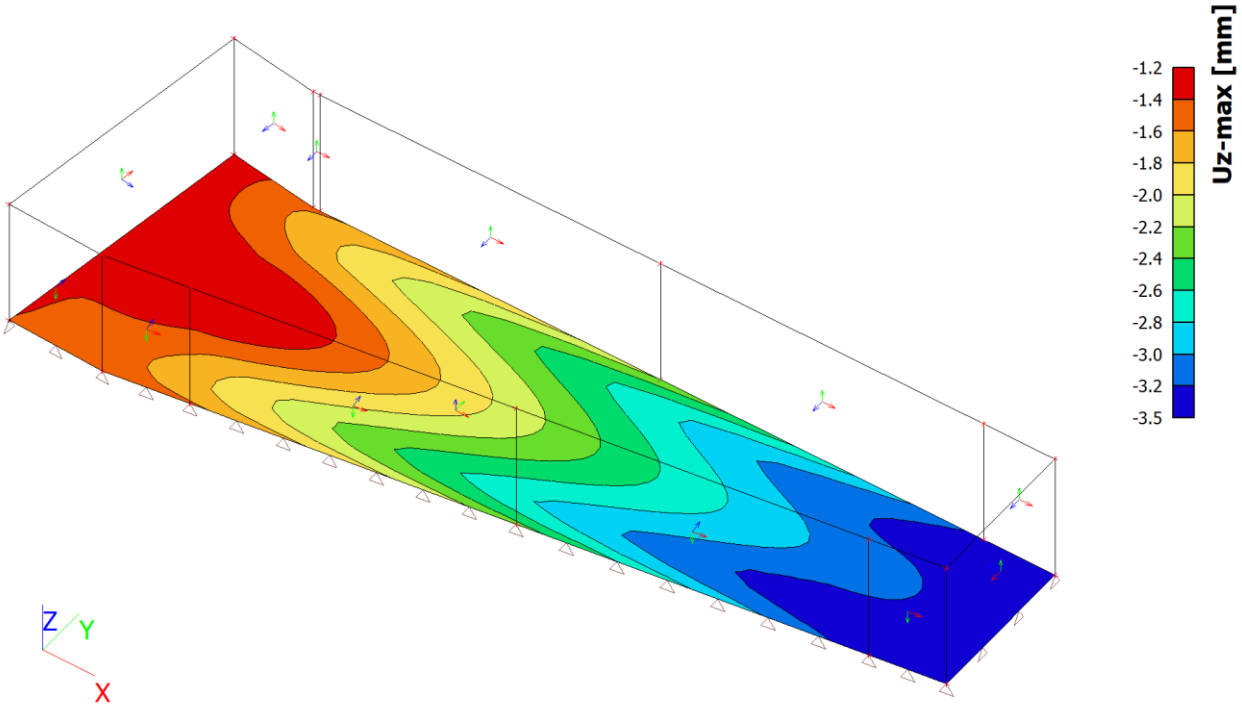
7.3. Displacement of nodes; Uz (SLS) max



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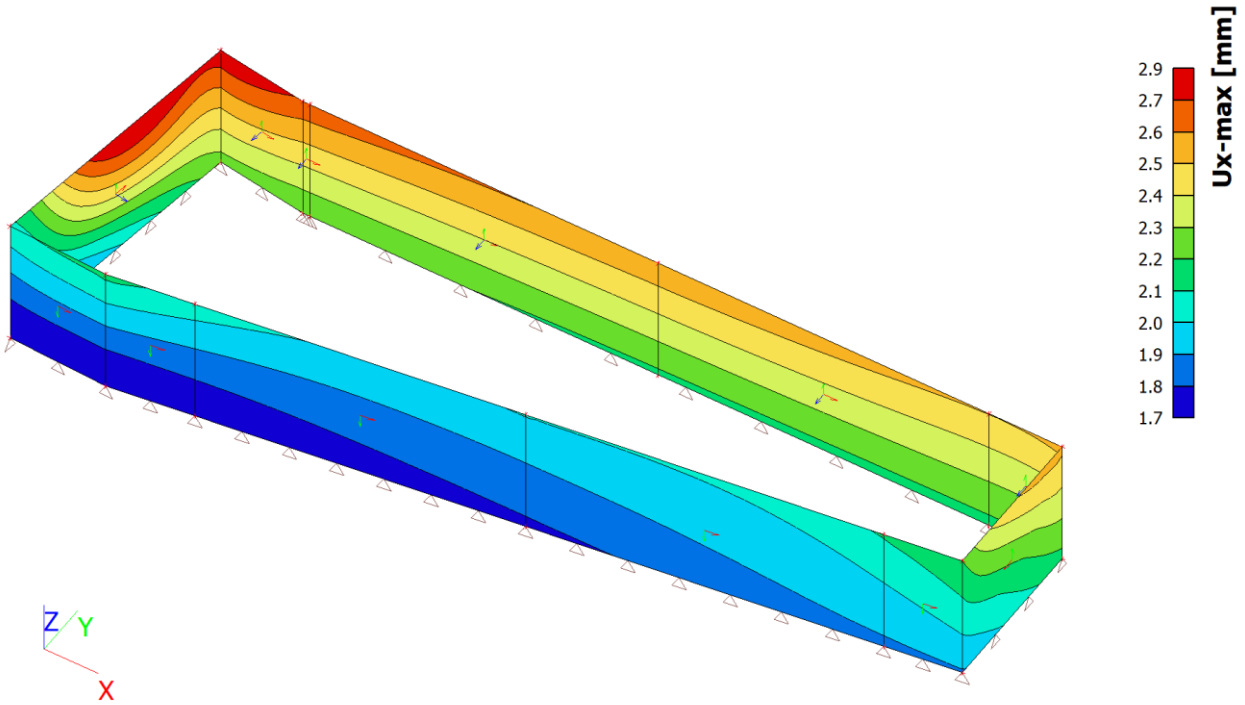
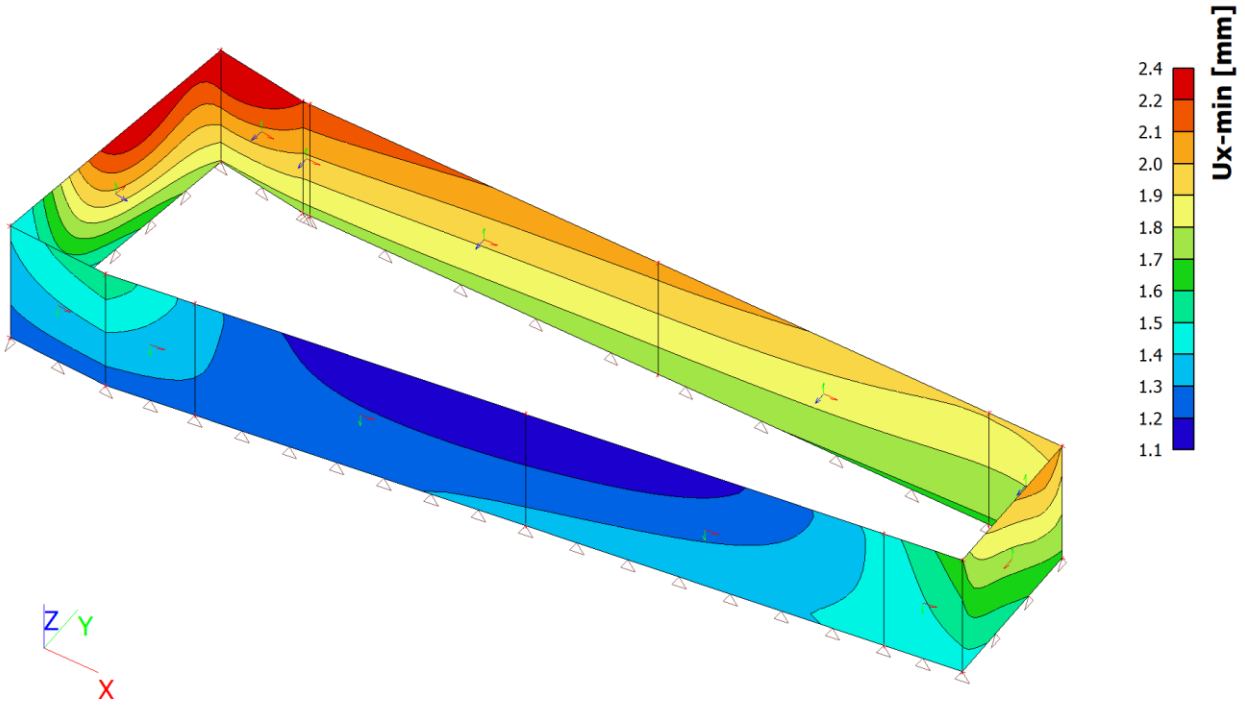
7.4. Displacement of nodes; Ux (SLS) max



7.5. Displacement of nodes; Ux (SLS) min



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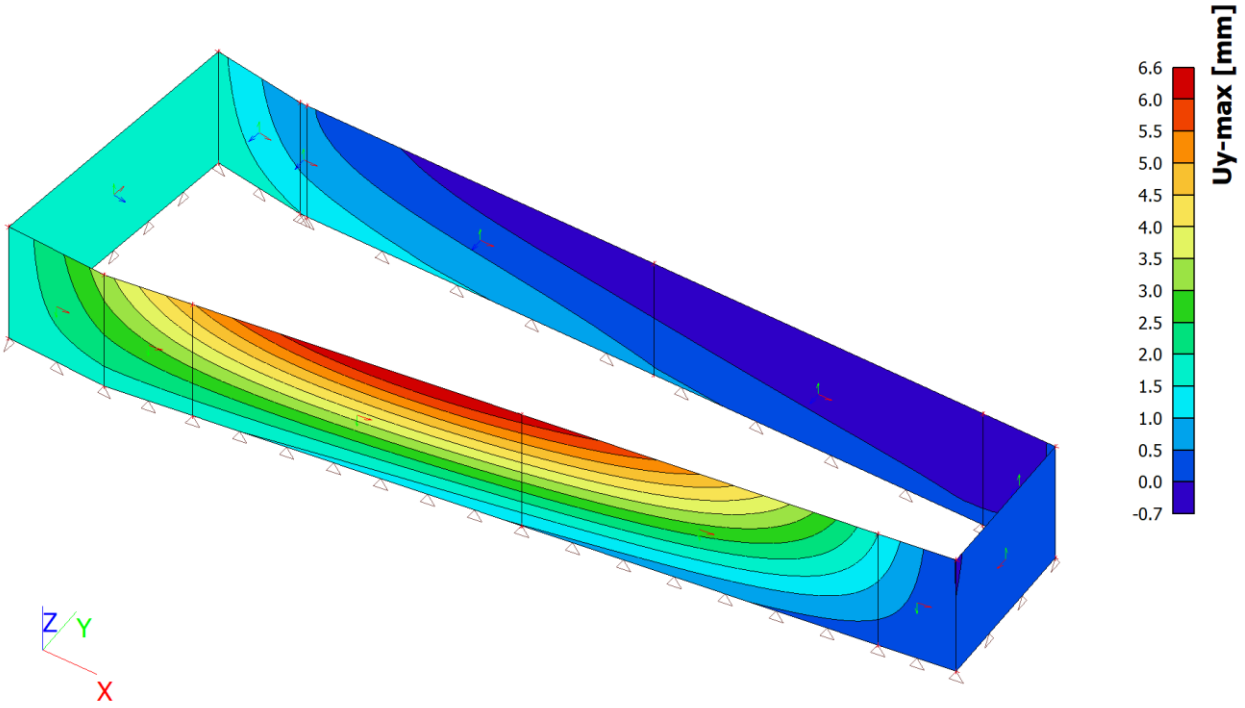
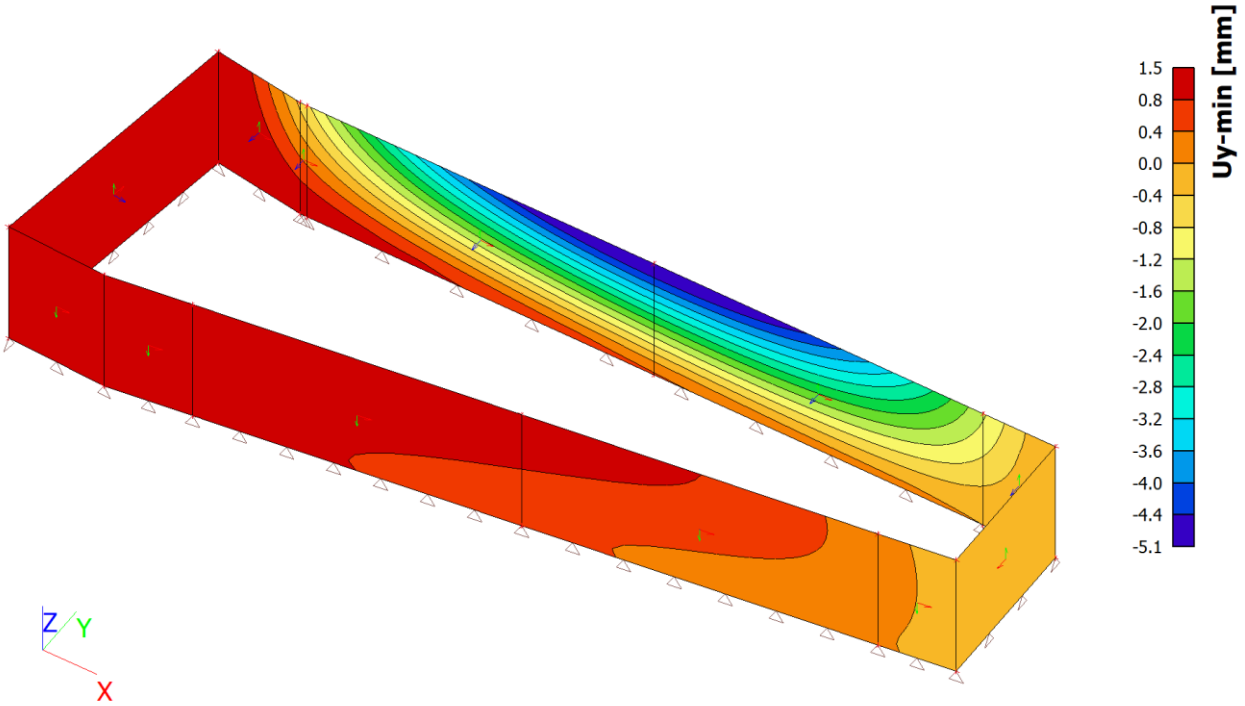
7.6. Displacement of nodes; Uy (SLS) max



7.7. Displacement of nodes; Uy (SLS) min



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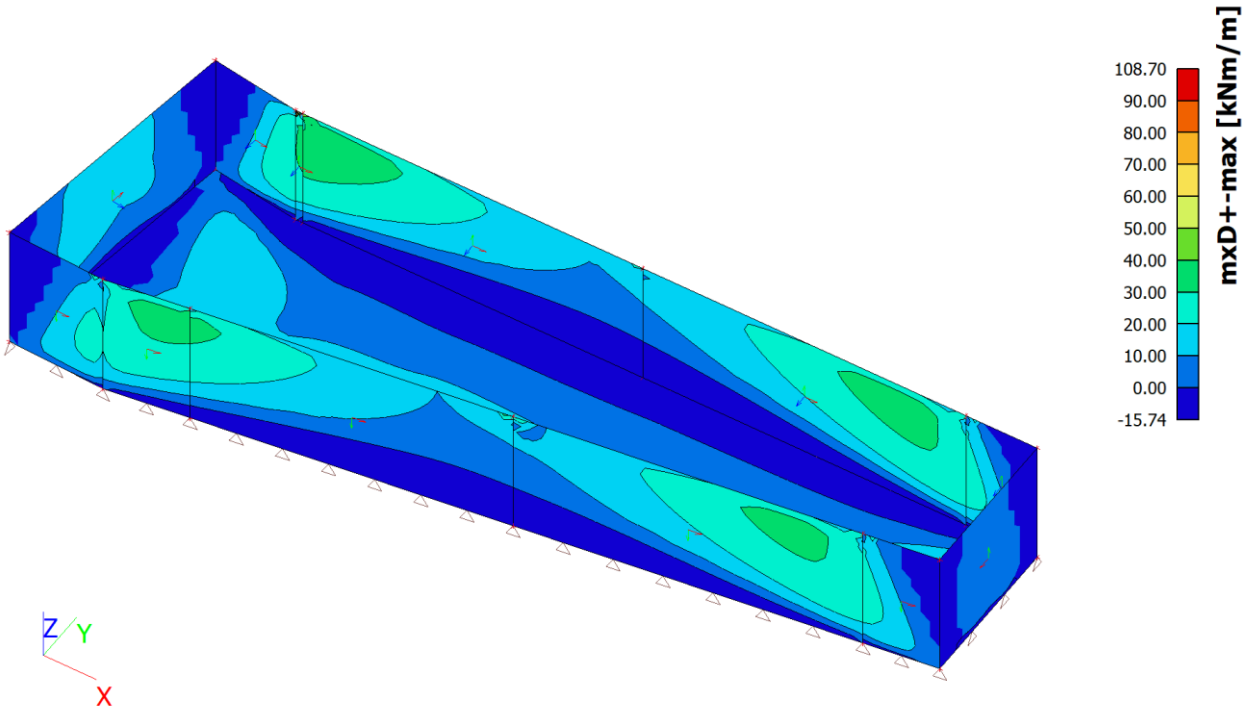
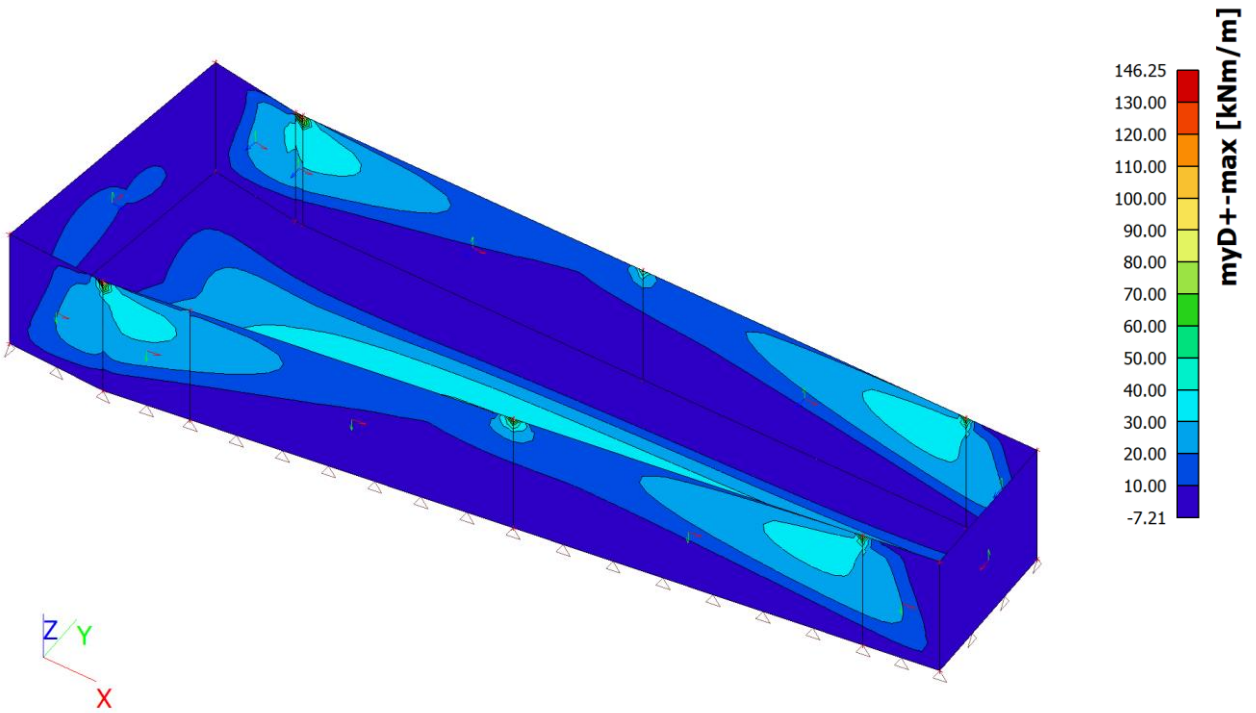
7.9. Internal Forces

7.9.1. 2D member - Internal forces; mxD+



7.9.2. 2D member - Internal forces; myD+



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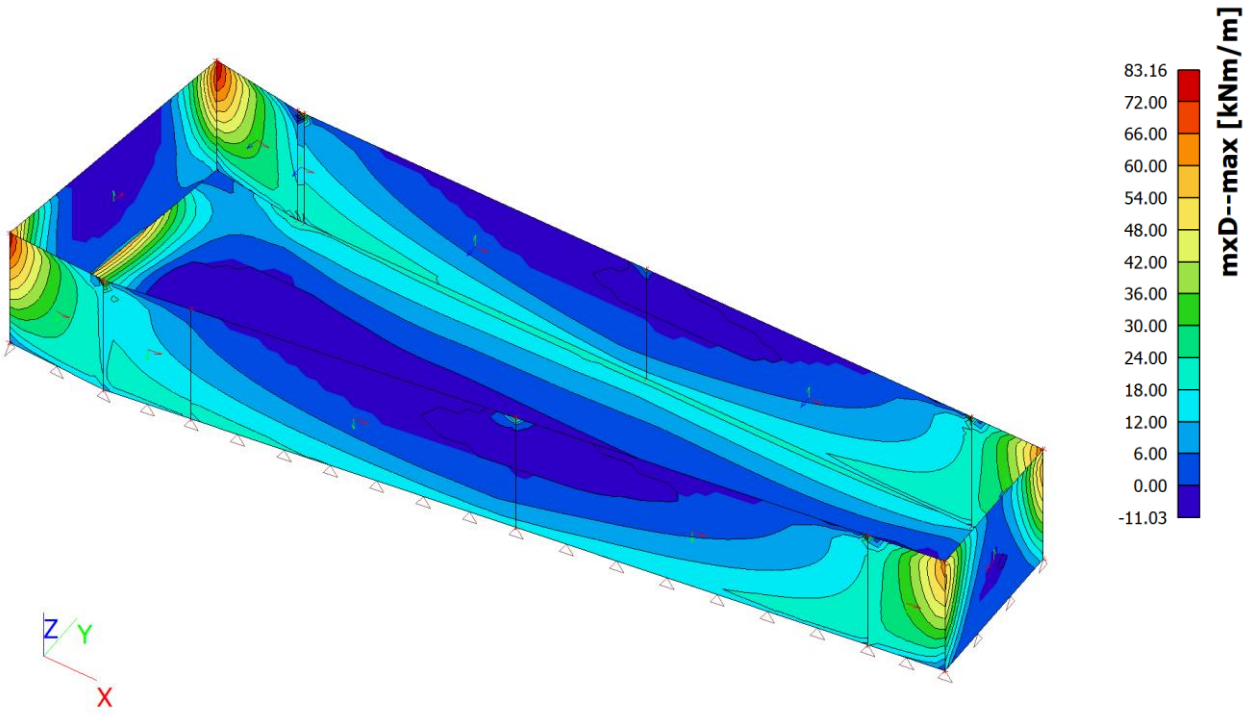
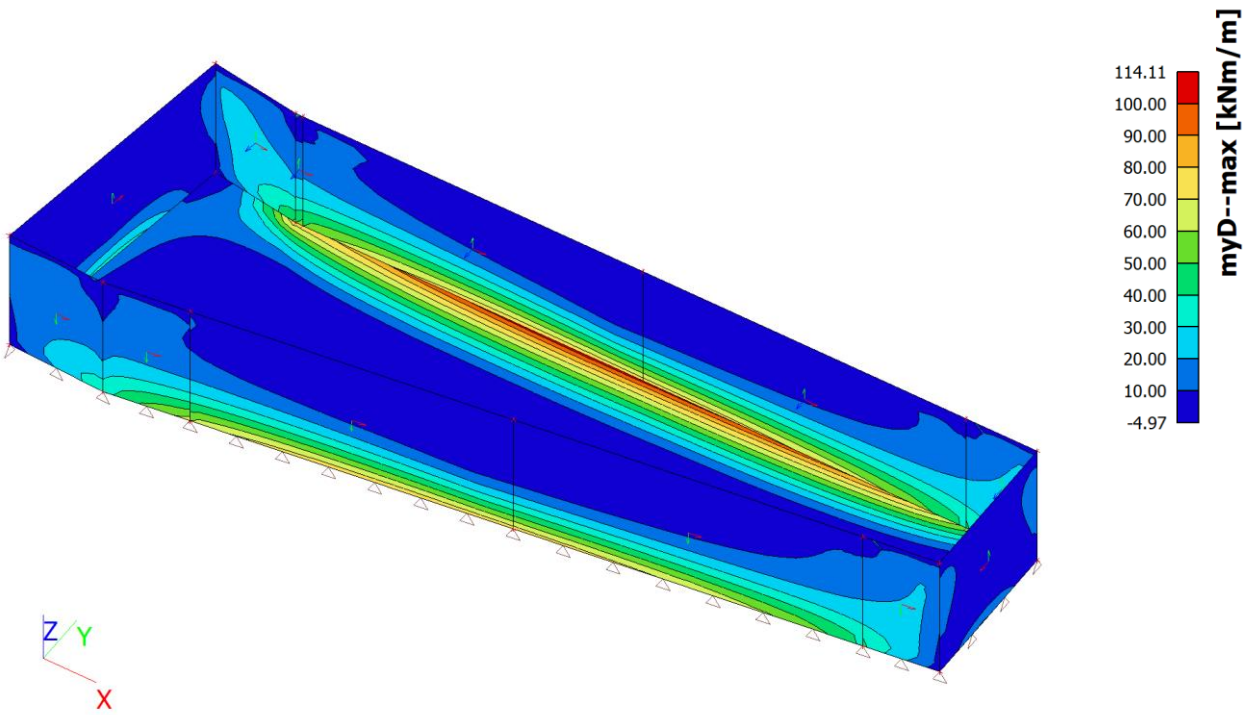
7.9.3. 2D member - Internal forces; mxD-



7.9.4. 2D member - Internal forces; myD-



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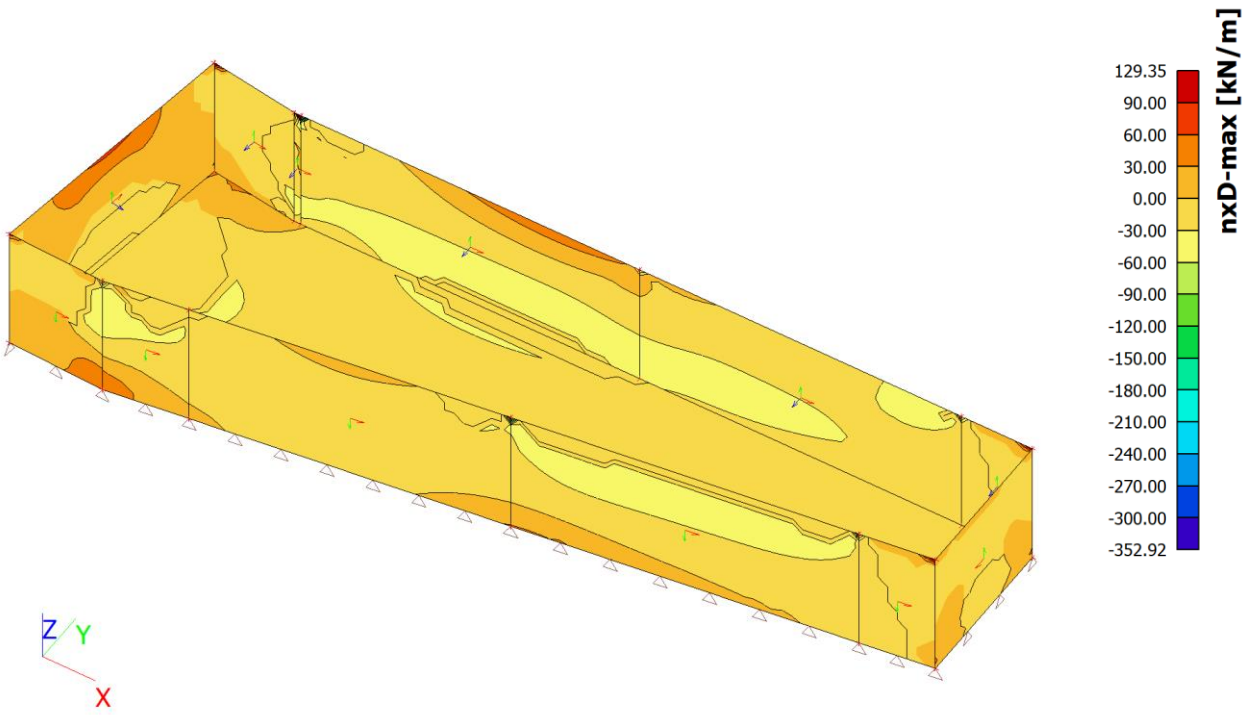
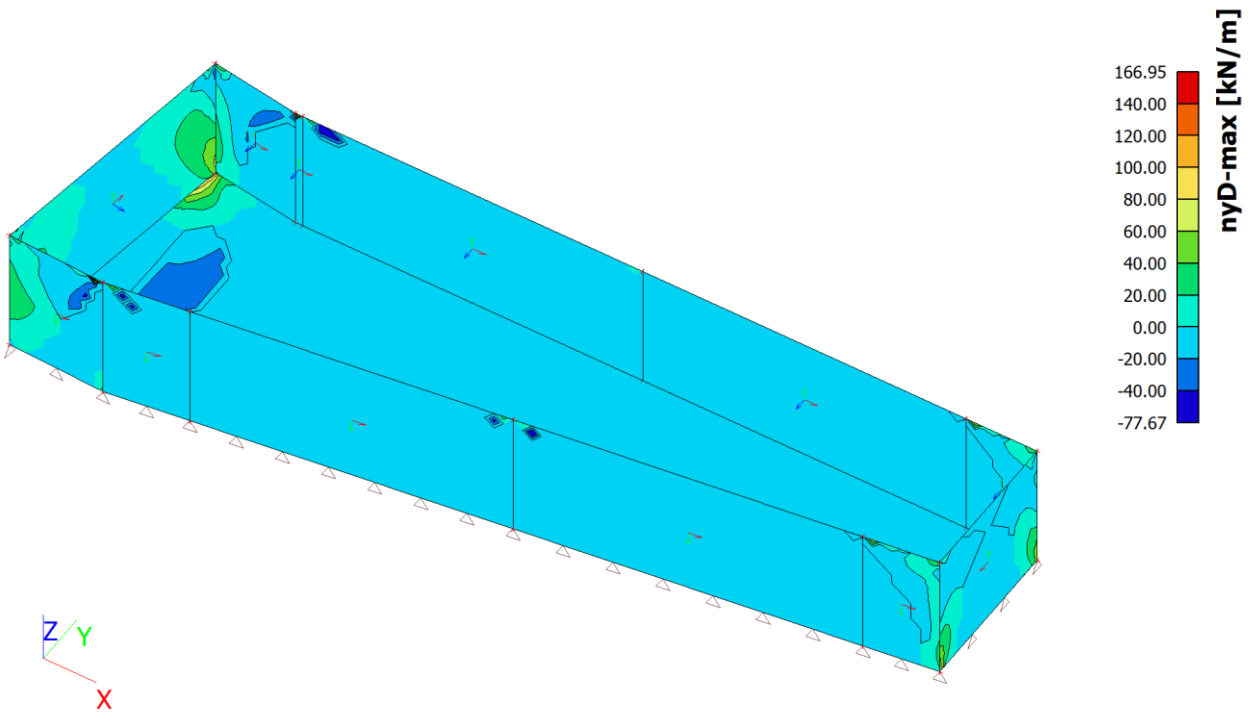
7.9.5. 2D member - Internal forces; nxD



7.9.6. 2D member - Internal forces; nyD



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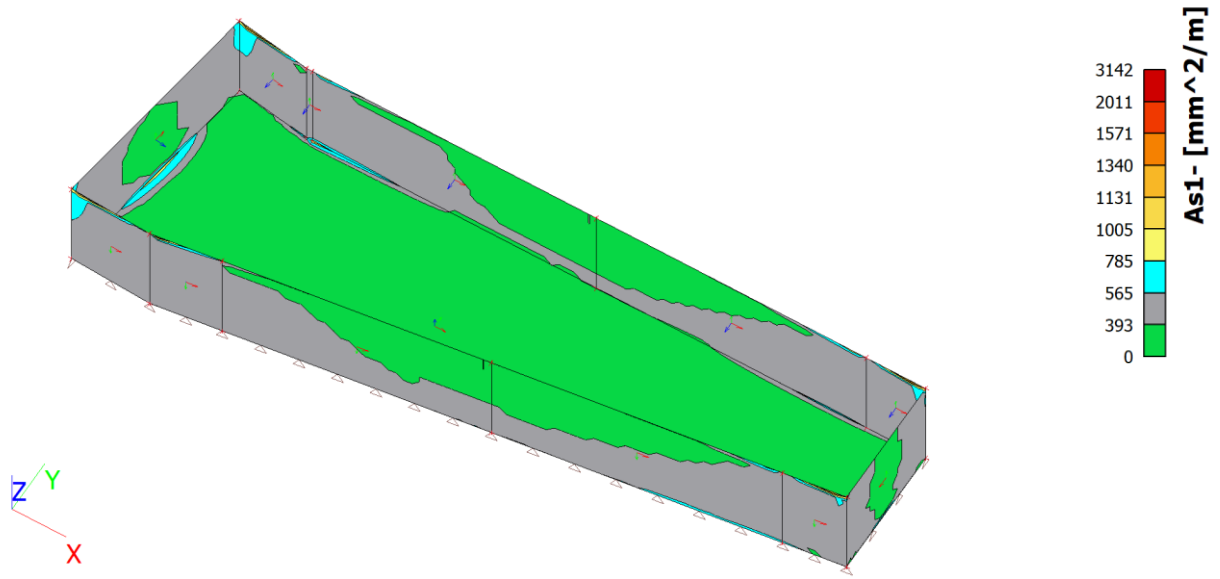
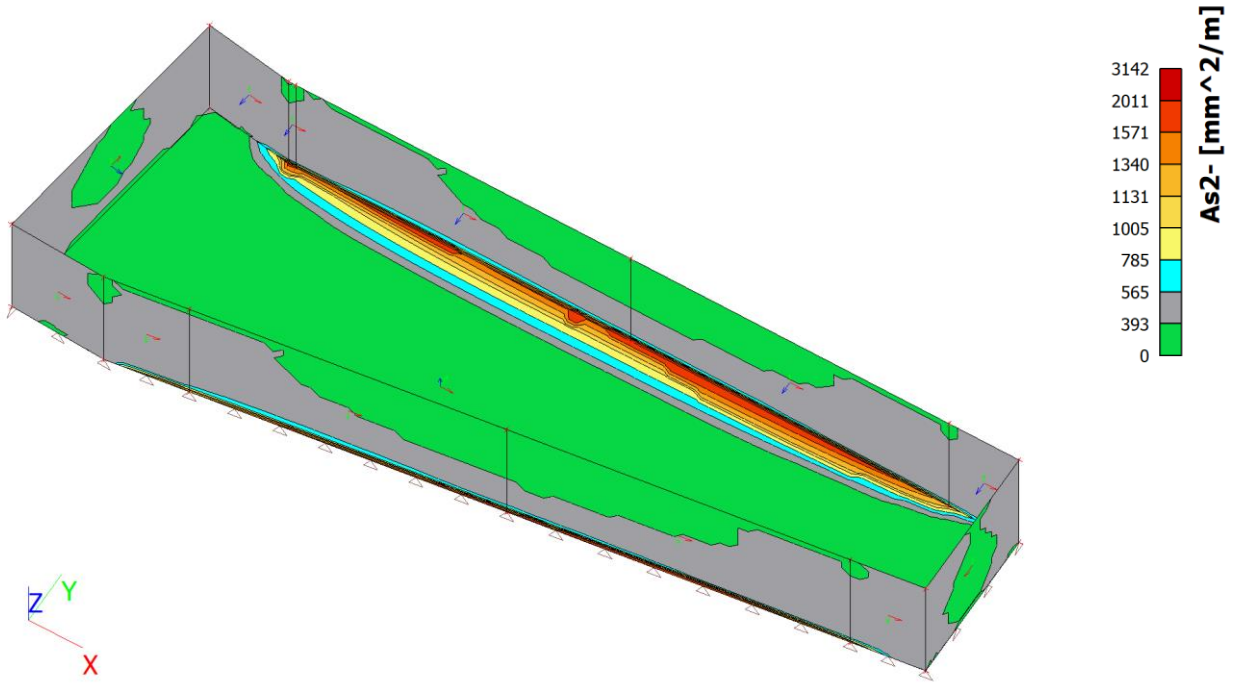
8. Design

8.1. Member 2D - design - required areas; As1- (ULS) Basement Slab Bottom - x, Walls Outer Face - x



8.2. Member 2D - design - required areas; As2- (ULS) - Basement Slab Bottom - y, Walls Outer Face - y



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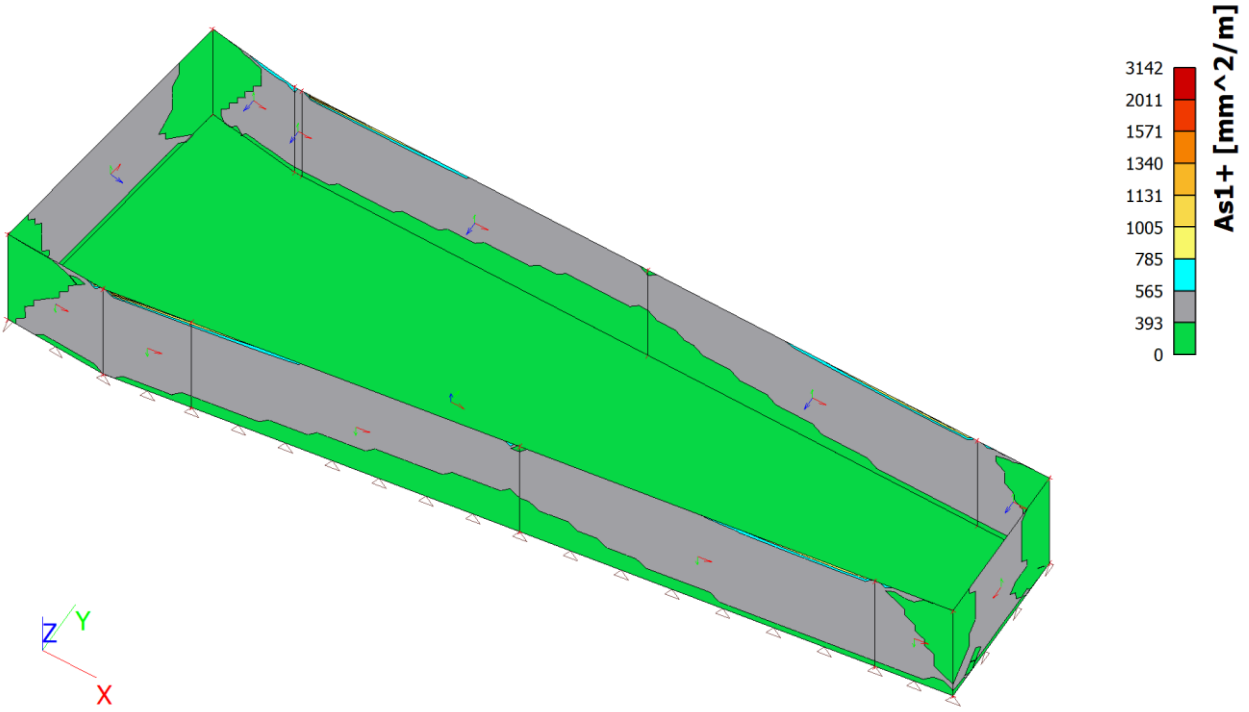
8.3. Member 2D - design - required areas; As1+ (ULS) Basement Slab Top - x, Walls Inner Face - x



8.4. Member 2D - design - required areas; As2+ (ULS) Basement Slab Top - y, Walls Inner Face - y