D001A
LOADING ASSESSMENT
KINGSTON BRIDGE HOUSE, HAMPTON WICK
RICHMOND, LONDON
KT1 4AG

Date: 21st AUGUST 2023
Ref: JS/TS/21173.D001A

INDEX

APPENDIX

ISSUE	PREPARED BY	CHECKED BY	DATE	NOTES
21173.D001	JS	TS	27.01.2023	
21173.D001A	RM	TS	22.08.2023	Assessment of balconies

1.0 INTRODUCTION

1.1 Shear Design Limited have been commissioned by Westcombe Group to prepare a loading assessment report for the proposed development at Kingston Bridge House, Church Road, Hampton Wick, KT1 4AG. This report has been prepared in support of the redevelopment of the site and has been commissioned to advise on the feasibility of providing a green/blue roof construction with photovoltaic panels on the roof of each block, 7-storey and 4-storey with respect to the loading on the structure.

1.2 In addition to the proposal outlined in section 1.1, Shear Design Limited have been commissioned by Westcombe Group to evaluate the structural feasibility of incorporating the proposed balconies while considering their potential impact on both the overall load distribution and the structural integrity of the existing structure. Section 2.14 outlines the typical construction details proposed for the balconies which we have adopted for our assessment. Sections 3.0 and 5.0 elaborate on the effects of the increased loading attributed to the balconies and provides well-considered conclusion and recommendations.

1.3 Shear Design Limited have carried out a high-level review of the proposed planning drawings and recommendations within the Flood Risk Assessment (FRA) completed by Lanmor Consulting (Ref: 201345/DS/JR/KBL/02 REVA) with regards to the proposed requirements for attenuation of the drainage on site and its effect on the loading of the existing structure.

1.4 To enable us to prepare this report, a visual walk around of the existing buildings were carried out on the 03rd February 2022 to determine the existing construction of the building where possible.

Photographs were taken during this inspection and are referenced within this report. Please refer to Appendix i.

1.5 The initial inspection of the existing buildings was purely a visual inspection, no finishes were removed, and no intrusive investigations were carried out during this inspection. No concrete testing has been undertaken as part of this report.

1.6 Further soft strip works were undertaken by the Contractor with all survey/measurement information on the existing structure being issued to Shear Design for use within their loading assessment. The site exposure works determined the wall construction thicknesses, column sizing/spacing, the floor slab thickness and the width/depths of existing reinforced concrete beams.

1.7 Guidance from the following publications have been utilised in the preparation of this report:-

"*Appraisal of Existing Structures – by Institution of Structural Engineers*"

1.8 We have not inspected all areas of the building or other parts of the structure which are covered, unexposed or inaccessible and we are therefore unable to report that any such part is free from defect. We cannot be held responsible for unforeseen conditions which may exist that are covered. Conditions may exist beneath the structure that are not detectable from our visual inspection.

1.9 The conclusions and recommendations in this report are based on reasonable influences from observations of limited areas of the building. It should be appreciated that general conclusions cannot be drawn with certainty from the limited observations and there is a possibility that our conclusions may need to be modified as a result of further works that will occur once the building is being refurbished and stripped out in the future.

1.10 This report is personal to Westcombe Group, is confidential and non-assignable unless noted otherwise in the Appointment Documents. Shear Design accepts no liability for losses suffered by any third parties as a result of reliance on this report.

2.0 EXISTING BUILDING AND PROPOSALS

2.1 Kingston Bridge House comprises of two blocks forming an L-shape currently made up of student living facilities which spans over the four-storey and seven-storey elements of the building. The property was originally constructed in the mid-1960's as office accommodation with the building being redeveloped in the mid-1990's to provide student accommodation. The building was again reconfigured at ground level in 2015 to provide an additional common room and bike storage.

2.2 The two blocks which currently provide student accommodation share almost identical and easily divisible floor plates with a central core connecting the blocks. See Photograph 1 showing the link between the existing four and seven storey structures.

2.3 The proposed development will consist of the conversion of the existing student living accommodation to residential apartments, a total of 70 units will be provided.

2.4 The existing frame consists of reinforced concrete columns spaced at approximately 1.5m centres externally, with a central line of columns at 6.0m centres internally (See Photograph 2).

2.5 The superstructure floor slabs consist of a 150mm thick reinforced concrete slab spanning between down stand beams (230mm depth) at 1.0m centres (Photograph 3). There is a central spine beam 1.9m wide x 230mm deep running the length of each wing which supports the perpendicular beams. For design considerations, the width of the edge beam is assumed to be half that of the central spine beam, which is 900mm wide with a depth of 230mm spanning between columns at 1.5m centres.

2.6 The ground floor slab construction is unknown. For the purpose of the loading assessment, we have assumed the ground floor slab is ground bearing.

2.7 The existing external wall construction consists of reinforced concrete walls min 200mm thick up to window sill level for ground and first floor levels, then consist of brick/block 225mm thick construction up to sill level for the upper floors. See Photograph 4 indicating the blockwork construction up to sill level on the upper floors of the structure. We understand the external skin of the masonry/RC was reclad in lightweight rendered board. We have utilised the proposals for the perimeter of the structures to incorporate a brickwork slip panel with SFS infills internally as part of the loading assessment.

2.8 There is a transfer slab level at 1st floor on the four-storey block of the development. This is made apparent by the change in column arrangement to form the parking under croft of the four-storey block. See Photographs 5 which shows the circular column arrangement from ground to first floor.

2.9 The existing roof coverings for both wings consist of asphalt finish under single ply and insulation over the standard reinforced concrete slab construction as noted above. See Photograph 6 of the four-storey roof.

2.10 The drainage requirements noted within the Lanmor Consulting drainage strategy report advises the use of a green/blue roof for attenuation purposes as part of the redevelopment of the scheme. Shear Design have completed a scheme rainwater drainage layout at roof level and have completed preliminary attenuation calculations to estimate the proposed green/blue roof system requirement. As a result of the design calculations, an estimated 100mm of attenuation within the construction build-up has been accounted for within the loading assessment. The final thickness of attenuation required will be confirmed at detailed design stage. See Appendix ii for 21173.D100 – Proposed Rainwater Drainage at Roof Level.

2.11 A Bauder green/blue roof solution has been utilised to assess the existing structures from an additional loading perspective. See Appendix iii for the system summary of the Bauder green/blue roof solution.

2.12 The introduction of photovoltaic cells (PV) on the roofs have been incorporated into the loading assessment. To negate the requirement of a ballasted PV system, we have utilised a BauderSOLAR system which is a mounting solution for framed PV panels onto the Bauder green/blue roof build-up. The system utilises the self-weight of the green/blue roof build-ups as ballast which helps to reduce proposed weights of the overall system. See Appendix iii for the system summary of the BauderSOLAR system.

2.13 Shear Design has adopted a Bauder roofing solution as an example. Within the detailed design, the client may choose a different supplier of the green/blue roof and PV solution. This may affect the associated loadings on the existing roofs and will need further verification against the loading assessment.

2.14 The proposed balcony additions are found at all upper floor levels of both the 7-storey and 4-storey blocks. Shear Design have received conceptual balcony designs from Fluent-ADS Limited. The design proposal comprises lightweight cantilevered balconies, intended to be anchored to the existing concrete perimeter beam through the use of cold-formed sections bolted to the perimeter beam with tie rods connecting the balcony back to the existing structure. Additionally, there are inset balconies where the perimeter walls are inset into the building with the existing columns remaining to the perimeter slab edge. The window openings will be positioned to suit the column perimeter centres. Accordingly, at the inset balcony locations there is no additional loading transferred to the structure as the floor area remains unchanged. See Appendix vi for the proposed proprietary cantilever balcony drawings.

3.0 LOADING ASSESSMENT

3.1 In order to assess the structural feasibility of adding a green/blue roof build-up and photovoltaic panels on the existing roof and adding balconies to the upper floors of both blocks, it must be demonstrated that the additional loadings associated with the proposals do not compromise the capacity of the existing structure and its foundations. At detailed design stage, a structural solution can be developed to accommodate additional loads on the existing structure where required.

3.2 The assessment was based on findings from the visual site inspection and further soft strip works completed by the Contractor. The floor depths have been measured and used within the calculations, and confirmed from the site exposure works. The findings from the exposure works have confirmed the assumptions made within the structural loading appraisal.

3.3 Within Appendix iv, a high-level loading assessment has been produced that compares the existing loadings against the proposed loadings. The investigative works and measurements provided by the Contractor have confirmed the assumptions within the calculations on the existing structural arrangement of each wing.

3.4 The loading assessment considers the critical load configuration of each element through the structure. The calculations completed utilise the thicknesses and construction type of the existing floor slabs for the loading assessment to provide what we consider to be an appropriate increase in loadings to the building's foundations of less than or equal to 10%.

3.5 The principles of the loading assessment incorporate the following updates of the applied loading to the building as part of the roof construction change. The below is subject to detailed design following receipt of subcontractor proposals with exact weights of the new roofing build-ups and photovoltaic systems finalised. In accordance with the codal floor loading requirements at the time of construction (British Standard CP3 PartV-1952), the office imposed floor loading would have been based 2.5kN/m^2. The proposal for conversion to residential accommodation reduces this imposed load to 2.0kN/m^2. Providing a saving of 0.5kN/m^2 (50kg/m^2) on each habitable floor plate. See the table below for the existing and proposed loadings of each floor and the roofs which change as part of the redevelopment:

Development Change	Existing Loading	Proposed Loading	Percentage Increase
Imposed Load from change of use from Office Loading to Residential Loading at each floor	2.50kN/m^2 + 1.0kN/m^2 Total 3.50kN/m^2	2.0kN/m^2 + 1.0kN/m^2 Total 3.0kN/m^2	-14% Decrease per floor
Roof Finishes	1.13kN/m^2	3.68kN/m^2	+226% Increase at roof level

3.6 The proposed balconies result in an additional dead load of 0.85 kN/m^2 at every floor level of the existing structure. When assessing the foundation load, we consider that the load imposed by the balconies is 1.5kN/m^2. This is because its impractical to assume that the balconies will be loaded concurrently with the residential floors. However, when assessing the localised impact of the proposed balconies on the existing structure, an imposed load of 2.5kN/m^2 has been adopted for design purposes.

3.7 We have analysed the 150mm thick roof slab spanning between the downstand beams at 1.0m centres. The existing roof slab has been checked using minimum area reinforcement and is acceptable for the loading increase as a result of the roof finish change.

3.8 We have analysed the roof slab downstand beams at 1.0m centres incorporating the updated roof finish loads and can confirm they are over utilised. The beams will need strengthening with hot rolled steelwork or will need the loaded areas reduced by 50%. This can be achieved by introducing additional steelwork between the 1.0m centres of the beams.

3.9 The internal columns have been analysed based on the proposed loading. The percentage load increase at roof level into the columns is an increase of 35%. Utilising a minimum area of reinforcement to meet the current codal requirements the column design is acceptable. As such the increase in loading as a result of the increase in roof finish weight is acceptable.

3.10 Previously the edge columns have been analysed based on the proposed green roof loading. The percentage load increase at roof level into the columns was found to be 35%. Additionally, the proposed balcony at this level introduces an extra 9% increase in loading to both blocks, resulting in a cumulative 44% increase. By utilising the minimum area of reinforcement to meet the current codal requirements, the column design is deemed acceptable. As such the increase in loading as a result of the increase in roof finish weight and balconies is regarded as acceptable for feasibility assessment.

3.11 At separating floors, the edge columns have been analysed based on the proposed balcony loading. The percentage increase is 12% per floor. By utilising the minimum area of reinforcement to meet the current codal requirements, the column design is deemed acceptable. As such the increase in loading as a result of the inclusion of balconies is regarded as acceptable for feasibility assessment.

3.12 The internal spine beam has been analysed at roof level to confirm the increase in roof loading is acceptable. The spine beam design works based on a minimum reinforcement of 11 No. - H16 bars in the bottom of the beam. The existing reinforcement within the beams will need to be investigated/verified on site.

3.13 The reinforced concrete edge beam will serve as a direct support for the balcony structure, provided that the steel reinforcement is exposed to allow for the assessment of its capacity against the additional balcony loading at the detailed design stage. Alternatively, a steel channel member could be utilised to evenly distribute the balcony load onto the edge beam. This can be achieved by anchoring the channel to the edge beam at regular intervals.

3.14 The 4-storey building has been previously analysed to confirm that the additional loading at foundation level due to the proposed green roof is less than 10%. The calculations confirm a foundation level increase of 3.5% for internal foundations and 1.8% for edge foundations. Additionally, the proposed balconies result in an additional load increase of 8.2% for edge foundations, resulting in a cumulative total increase of 10% increase. In our considered opinion, this increase is viewed as acceptable.

3.15 The 7-storey building has been analysed to confirm that the increase in loading at foundation level is less than 10%. The previous calculations, which were based on the added loading from the green roof, confirmed that there is no increase at the foundation level due to the reduction in imposed loading through change of use from office to residential loadings. This saving of $0.5kN/m^2$ at each floor level counteracts the increase in loading introduced. The proposed balconies add an additional loading increase of 8% to the edge foundations. Given that this increase remains below 10%, we consider it acceptable in our opinion.

4.0 FURTHER INVESTIGATIONS/RECOMMENDATIONS

4.1 An allowance must be incorporated into the proposals for strengthening the existing downstand beams of each roof slab to ensure structural integrity remains when supporting the increased loading from the new roof finishes. The exact strengthening requirements will be provided during the detailed design of the proposals; however, an additional line of steel beams can be expected to help reduce the loaded areas on the existing reinforced concrete downstand beams.

4.2 Intrusive investigations must be completed on site to confirm the existing reinforcement size/spacing and cover within the internal spine and external perimeter beams at roof level. It would be prudent to allow for strengthening works at costing stage if minimum reinforcement is not found during the validation exposure works. A markup of required exposure works can be provided during the detailed design of the scheme.

4.3 Intrusive investigations must be completed on site to confirm the existing reinforcement size/spacing and cover within the existing columns below roof level, ground floor columns to podium and a small number of targeted columns throughout the height of the building. Providing minimum area of reinforcement is present, the column integrity remains. A markup of required exposure works can be provided during the detailed design of the scheme.

4.4 Intrusive investigations must be completed on site to confirm the existing reinforcement size/spacing and cover within the existing perimeter beams at separating floor levels and the podium transfer beams within the 4-storey block at first floor level. An evaluation of the perimeter beams and the transfer beam is required to ascertain whether strengthening enhancements are needed to accommodate the additional forces introduced by the balcony connections.

5.0 CONCLUSION

5.1 Shear Design have visited and carried out a walk around visual inspection of Kingston Bridge House, Hampton Wick, London and compiled a loading assessment so to investigate the feasibility of adding a green/blue roof and photovoltaic panels on the existing building with respect to an increase in loading.

As a result of the above the conclusions are as follows:

- The attenuation requirement for the green/blue roof has preliminarily been calculated as 100mm thickness of attenuation across the roofs. This is subject to detailed design in co-ordination with the specialist supplier of the roofing system.

- The proposed roofing system has been based on a Bauder roofing solution as an example. Within the detailed design, the client may choose a different supplier of the green/blue roof and PV solution. This may affect the associated loadings on the existing roofs and will need further verification against the loading assessment.

- The existing roof construction for each wing of the building requires strengthening to ensure structural integrity remains. Exact strengthening to be confirming within the detailed design.

- The existing roof spine and edge beams require further intrusive investigations to confirm validity of the additional loads ensuring structural integrity remains.

- The existing perimeter and transfer beams require further intrusive investigation to confirm their adequacy to support the loading from the balconies. Localised strengthening works may be required which will be determined in detailed design stage but can be provided by use of bolted steelwork plates or similar.

- The existing columns have been analysed with respect to additional loadings from the proposed green roof and balconies and we can advise that based on utilising minimum area of reinforcement within the columns they have capacity to support the additional loads from the redevelopment. The columns, as identified in section 4.0 will require intrusive investigations. Subject to these, localised strengthening work may be required but can be accommodated adopting bolted steelwork places or similar.

- The existing foundations have been analysed to determine the loading increase percentage as a result of the redevelopment comprising additional green roof and balconies. The foundations of the 4-storey and 7-storey wings do not increase greater than 10% and as such are within acceptable limits for the capacity of the existing foundations.

5.2 Based on the loading assessment calculations and subject to the recommendations/conclusions within this report, it is our considered opinion that the existing building is capable of supporting the additional loadings associated with the roof finishes and inclusion of balconies of the proposed redevelopment.

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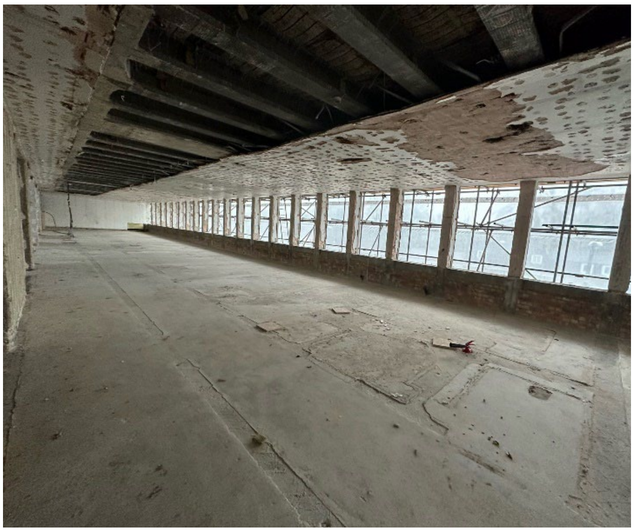
21st AUGUST 2023

APPENDIX

i) PHOTOGRAPHS

PHOTOGRAPH 1

PHOTOGRAPH 2



PHOTOGRAPH 3

PHOTOGRAPH 4

PHOTOGRAPH 5

PHOTOGRAPH 6

APPENDIX

ii) 21173.D100 PROPOSED RAINWATER DRAINAGE AT ROOF LEVEL

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21173.D100

RESIDENTIAL DEVELOPMENT, KINGSTON BRIDGE HOUSE, HAMPTON COURT ROAD, CHURCH GOVE, LONDON

PROPOSED RAINWATER DRAINAGE AT ROOF LEVEL

CONTRACT NO:	**21173.D100**
DATE:	**23.01.2023**
BY:	**TU**

DOCUMENT INDEX SHEET

Contract: **KINGSTON BRIDGE HOUSE** Project No: **21173**

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Issue	Prepared by	Checked by	NOTES	Date
-	TU	TS	First Issue	23/01/2023

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1.0 ROOF DRAINAGE OVERVIEW

These Calculations are based on Lanmor Consulting's drainage strategy report dated January 2023 with reference 201345/DS/JR/KBL/02 REV A.

All drainage parameters used by Shear Design within the MicroDrainage software match those used in the drainage strategy for the 1:100 year return period and 40% climate change. The only minor difference is the value adopted for ratio R derived from MicroDrainage mapping (0.405) rather than the figure used in the report (0.411).

The roofs work within a total discharge rate of 2.0 l/s utilising a 100mm depth cellular storage system. The calculations include an allowance for 20% siltation resulting in an effective long-term porosity of 77% compared with a newly installed porosity value of 95%. With reference to the drawing in Appendix C we have assumed the presence of parapets and a 1.0-metre-wide perimeter margin that reduces the area available for rainwater detention.

The Church Grove block has proportionally more functioning green/blue roof area allowing the discharge to be restricted to 0.6 l/s

The Hampton Court Road block has comparatively less functioning green/blue roof area requiring the flow to be restricted to no less than 1.4 l/s. The perimeter margin was reduced from a width of 1.0m to a width of 0.7m to sufficiently increase the proportion of functioning green/blue roof area.

APPENDIX A

RAINWATER CALCULATIONS HAMPTON COURT ROAD BLOCK

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 160 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.891	0.056	0.0	1.2	1.2	13.1	O K
30 min Summer	9.905	0.070	0.0	1.3	1.3	16.5	O K
60 min Summer	9.916	0.081	0.0	1.3	1.3	19.1	O K
120 min Summer	9.920	0.085	0.0	1.3	1.3	19.9	O K
180 min Summer	9.917	0.082	0.0	1.3	1.3	19.1	O K
240 min Summer	9.913	0.078	0.0	1.3	1.3	18.3	O K
360 min Summer	9.907	0.072	0.0	1.3	1.3	16.9	O K
480 min Summer	9.902	0.067	0.0	1.3	1.3	15.7	O K
600 min Summer	9.897	0.062	0.0	1.2	1.2	14.5	O K
720 min Summer	9.892	0.057	0.0	1.2	1.2	13.4	O K
960 min Summer	9.883	0.048	0.0	1.2	1.2	11.3	O K
1440 min Summer	9.868	0.033	0.0	1.1	1.1	7.8	O K
2160 min Summer	9.852	0.017	0.0	1.0	1.0	3.9	O K
2880 min Summer	9.841	0.006	0.0	1.0	1.0	1.5	O K
4320 min Summer	9.835	0.000	0.0	0.9	0.9	0.0	O K
5760 min Summer	9.835	0.000	0.0	0.7	0.7	0.0	O K
7200 min Summer	9.835	0.000	0.0	0.6	0.6	0.0	O K
8640 min Summer	9.835	0.000	0.0	0.5	0.5	0.0	O K
10080 min Summer	9.835	0.000	0.0	0.4	0.4	0.0	O K
15 min Winter	9.898	0.063	0.0	1.2	1.2	14.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.754	0.0	14.2	18
30 min Summer	90.906	0.0	18.6	33
60 min Summer	56.713	0.0	23.3	62
120 min Summer	34.176	0.0	28.1	118
180 min Summer	25.072	0.0	30.9	146
240 min Summer	20.006	0.0	32.9	178
360 min Summer	14.514	0.0	35.8	246
480 min Summer	11.557	0.0	38.0	314
600 min Summer	9.678	0.0	39.8	382
720 min Summer	8.369	0.0	41.3	450
960 min Summer	6.648	0.0	43.8	580
1440 min Summer	4.799	0.0	47.4	836
2160 min Summer	3.459	0.0	51.2	1188
2880 min Summer	2.739	0.0	54.1	1528
4320 min Summer	1.968	0.0	58.5	0
5760 min Summer	1.556	0.0	61.6	0
7200 min Summer	1.295	0.0	64.1	0
8640 min Summer	1.115	0.0	66.2	0
10080 min Summer	0.982	0.0	68.1	0
15 min Winter	138.754	0.0	15.9	18

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.915	0.080	0.0	1.3	1.3	18.8	O K
60 min Winter	9.929	0.094	0.0	1.4	1.4	22.0	O K
120 min Winter	9.934	0.099	0.0	1.4	1.4	23.3	O K
180 min Winter	9.931	0.096	0.0	1.4	1.4	22.6	O K
240 min Winter	9.927	0.092	0.0	1.4	1.4	21.6	O K
360 min Winter	9.918	0.083	0.0	1.3	1.3	19.6	O K
480 min Winter	9.911	0.076	0.0	1.3	1.3	17.8	O K
600 min Winter	9.903	0.068	0.0	1.3	1.3	16.0	O K
720 min Winter	9.896	0.061	0.0	1.2	1.2	14.3	O K
960 min Winter	9.883	0.048	0.0	1.2	1.2	11.2	O K
1440 min Winter	9.862	0.027	0.0	1.1	1.1	6.2	O K
2160 min Winter	9.841	0.006	0.0	1.0	1.0	1.3	O K
2880 min Winter	9.835	0.000	0.0	0.9	0.9	0.0	O K
4320 min Winter	9.835	0.000	0.0	0.6	0.6	0.0	O K
5760 min Winter	9.835	0.000	0.0	0.5	0.5	0.0	O K
7200 min Winter	9.835	0.000	0.0	0.4	0.4	0.0	O K
8640 min Winter	9.835	0.000	0.0	0.4	0.4	0.0	O K
10080 min Winter	9.835	0.000	0.0	0.3	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.906	0.0	20.9	32
60 min Winter	56.713	0.0	26.1	60
120 min Winter	34.176	0.0	31.4	116
180 min Winter	25.072	0.0	34.6	166
240 min Winter	20.006	0.0	36.9	188
360 min Winter	14.514	0.0	40.1	266
480 min Winter	11.557	0.0	42.6	340
600 min Winter	9.678	0.0	44.6	414
720 min Winter	8.369	0.0	46.3	484
960 min Winter	6.648	0.0	49.0	620
1440 min Winter	4.799	0.0	53.1	878
2160 min Winter	3.459	0.0	57.4	1208
2880 min Winter	2.739	0.0	60.7	0
4320 min Winter	1.968	0.0	65.5	0
5760 min Winter	1.556	0.0	69.0	0
7200 min Winter	1.295	0.0	71.8	0
8640 min Winter	1.115	0.0	74.2	0
10080 min Winter	0.982	0.0	76.2	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.405	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.055

Time From:	(mins) To:	Area (ha)
0	4	0.055

Time Area Diagram

Total Area (ha) 0.000

Time From:	(mins) To:	Area (ha)
0	4	0.000

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.835 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.77
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	305.0	0.0	0.201	0.0	0.0
0.200	305.0	0.0			

Complex Outflow Control

Orifice

Diameter (m) 0.010 Discharge Coefficient 0.600 Invert Level (m) 9.735

Orifice

Diameter (m) 0.010 Discharge Coefficient 0.600 Invert Level (m) 9.735

Orifice

Diameter (m) 0.010 Discharge Coefficient 0.600 Invert Level (m) 9.735

Orifice

Diameter (m) 0.010 Discharge Coefficient 0.600 Invert Level (m) 9.735

Orifice

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APPENDIX B

RAINWATER CALCULATIONS CHURCH GROVE BLOCK

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 432 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.878	0.043	0.0	0.5	0.5	14.0	O K
30 min Summer	9.890	0.055	0.0	0.6	0.6	18.1	O K
60 min Summer	9.902	0.067	0.0	0.6	0.6	21.9	O K
120 min Summer	9.911	0.076	0.0	0.6	0.6	24.8	O K
180 min Summer	9.914	0.079	0.0	0.6	0.6	25.8	O K
240 min Summer	9.914	0.079	0.0	0.6	0.6	25.9	O K
360 min Summer	9.912	0.077	0.0	0.6	0.6	25.1	O K
480 min Summer	9.909	0.074	0.0	0.6	0.6	24.2	O K
600 min Summer	9.906	0.071	0.0	0.6	0.6	23.3	O K
720 min Summer	9.904	0.069	0.0	0.6	0.6	22.5	O K
960 min Summer	9.900	0.065	0.0	0.6	0.6	21.2	O K
1440 min Summer	9.893	0.058	0.0	0.6	0.6	18.8	O K
2160 min Summer	9.883	0.048	0.0	0.6	0.6	15.6	O K
2880 min Summer	9.874	0.039	0.0	0.5	0.5	12.7	O K
4320 min Summer	9.859	0.024	0.0	0.5	0.5	8.0	O K
5760 min Summer	9.849	0.014	0.0	0.5	0.5	4.6	O K
7200 min Summer	9.842	0.007	0.0	0.5	0.5	2.2	O K
8640 min Summer	9.837	0.002	0.0	0.5	0.5	0.7	O K
10080 min Summer	9.835	0.000	0.0	0.4	0.4	0.0	O K
15 min Winter	9.883	0.048	0.0	0.6	0.6	15.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.754	0.0	14.4	19
30 min Summer	90.906	0.0	18.9	33
60 min Summer	56.713	0.0	23.6	62
120 min Summer	34.176	0.0	28.5	122
180 min Summer	25.072	0.0	31.4	182
240 min Summer	20.006	0.0	33.5	240
360 min Summer	14.514	0.0	36.4	336
480 min Summer	11.557	0.0	38.7	390
600 min Summer	9.678	0.0	40.5	452
720 min Summer	8.369	0.0	42.0	518
960 min Summer	6.648	0.0	44.5	654
1440 min Summer	4.799	0.0	48.2	924
2160 min Summer	3.459	0.0	52.1	1324
2880 min Summer	2.739	0.0	55.0	1728
4320 min Summer	1.968	0.0	59.3	2464
5760 min Summer	1.556	0.0	62.6	3168
7200 min Summer	1.295	0.0	65.2	3824
8640 min Summer	1.115	0.0	67.5	4496
10080 min Summer	0.982	0.0	69.3	0
15 min Winter	138.754	0.0	16.2	18

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.897	0.062	0.0	0.6	0.6	20.4	O K
60 min Winter	9.911	0.076	0.0	0.6	0.6	24.7	O K
120 min Winter	9.921	0.086	0.0	0.6	0.6	28.3	O K
180 min Winter	9.925	0.090	0.0	0.6	0.6	29.6	O K
240 min Winter	9.927	0.092	0.0	0.6	0.6	30.0	O K
360 min Winter	9.926	0.091	0.0	0.6	0.6	29.6	O K
480 min Winter	9.922	0.087	0.0	0.6	0.6	28.6	O K
600 min Winter	9.919	0.084	0.0	0.6	0.6	27.5	O K
720 min Winter	9.916	0.081	0.0	0.6	0.6	26.5	O K
960 min Winter	9.910	0.075	0.0	0.6	0.6	24.6	O K
1440 min Winter	9.899	0.064	0.0	0.6	0.6	21.1	O K
2160 min Winter	9.885	0.050	0.0	0.6	0.6	16.3	O K
2880 min Winter	9.872	0.037	0.0	0.5	0.5	12.1	O K
4320 min Winter	9.852	0.017	0.0	0.5	0.5	5.6	O K
5760 min Winter	9.839	0.004	0.0	0.5	0.5	1.4	O K
7200 min Winter	9.835	0.000	0.0	0.4	0.4	0.0	O K
8640 min Winter	9.835	0.000	0.0	0.4	0.4	0.0	O K
10080 min Winter	9.835	0.000	0.0	0.3	0.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.906	0.0	21.2	33
60 min Winter	56.713	0.0	26.5	62
120 min Winter	34.176	0.0	32.0	120
180 min Winter	25.072	0.0	35.2	178
240 min Winter	20.006	0.0	37.5	234
360 min Winter	14.514	0.0	40.8	344
480 min Winter	11.557	0.0	43.3	446
600 min Winter	9.678	0.0	45.4	478
720 min Winter	8.369	0.0	47.1	556
960 min Winter	6.648	0.0	49.9	710
1440 min Winter	4.799	0.0	54.0	1010
2160 min Winter	3.459	0.0	58.4	1428
2880 min Winter	2.739	0.0	61.7	1840
4320 min Winter	1.968	0.0	66.5	2552
5760 min Winter	1.556	0.0	70.1	3176
7200 min Winter	1.295	0.0	73.1	0
8640 min Winter	1.115	0.0	75.5	0
10080 min Winter	0.982	0.0	77.6	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.405	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.056

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.056

Time Area Diagram

Total Area (ha) 0.000

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.000

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.835 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.77
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	425.0	0.0	0.101	0.0	0.0
0.100	425.0	0.0			

Complex Outflow Control

Orifice

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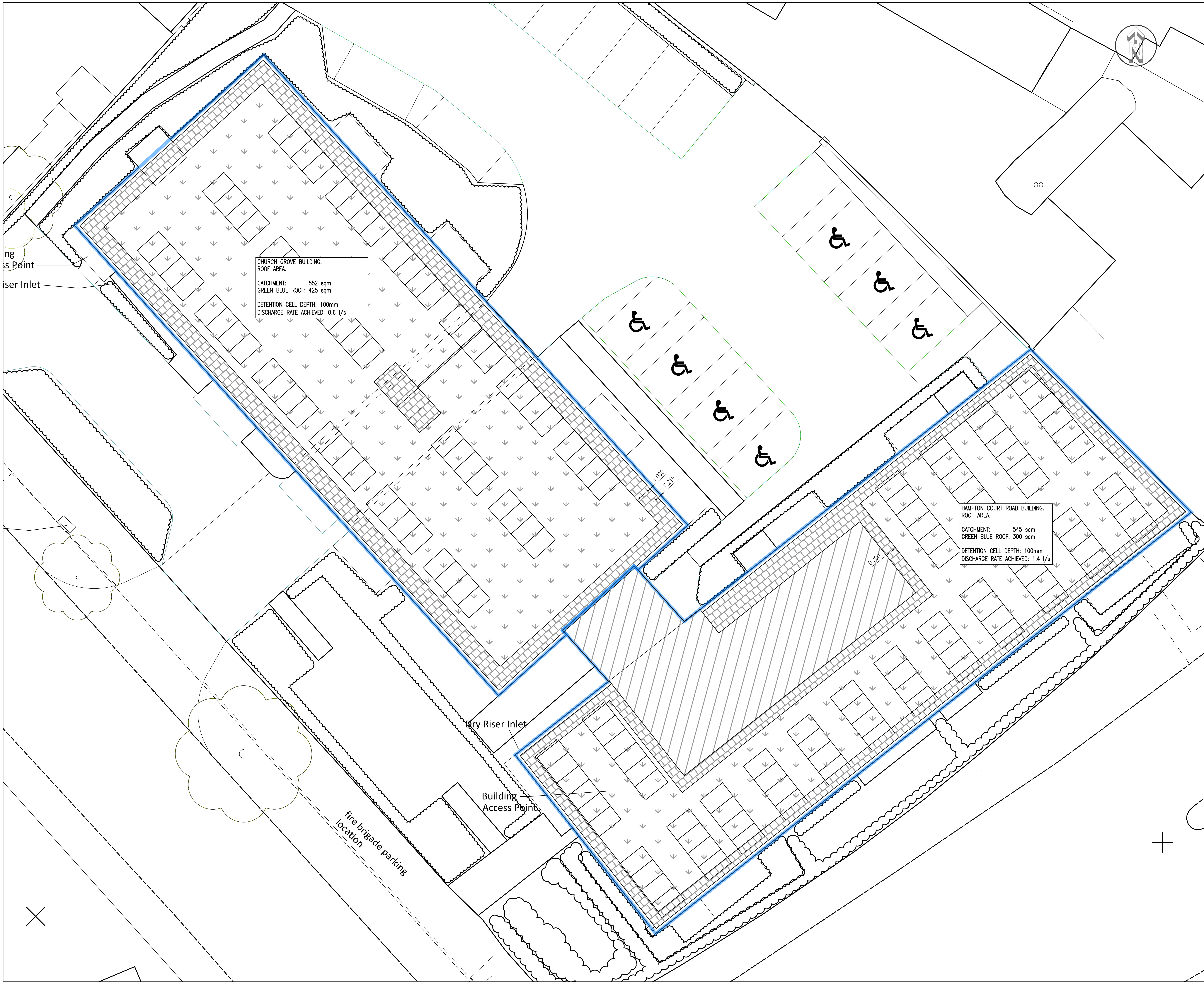
APPENDIX C

DRAINAGE LAYOUT AT ROOF LEVEL



NOTES

GENERAL
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
ALL LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS RELATE TO ORDNANCE DATUM UNLESS NOTED OTHERWISE.
3. DO NOT SCALE FROM THIS DRAWING. USE FIGURED DIMENSIONS ONLY.
4. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ENGINEER.
5. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, SUBCONTRACTORS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
6. THIS DRAWING IS COPYRIGHT © PROPERTY OF SHEAR DESIGN LIMITED.

PLANT ROOM, STAIR RISER, LIFT SHAFT ROOF AREA.

PAVING, PARAPETS AND OTHER ROOF AREAS.

AREAS AVAILABLE FOR GREEN BLUE ROOF DRAINAGE SYSTEMS.

EXTENT OF RAINWATER CATCHMENT

REV	DATE	DESCRIPTION	BY	CHK

AMENDMENTS

CLIENT: WESTCOMBE GROUP

PROJECT: KINGSTON BRIDGE HOUSE
CHURCH GROVE, HAMPTON WICK

TITLE: DRAINAGE LAYOUT
ROOF LEVEL

SHEAR design
Consulting Civil and Structural Engineers

7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW
Tel: 029 2054 7000 - Fax: 029 2054 7001 - www.shear-design.com - enquiries@shear-design.com

DRAWN: TU	CHECKED: TS	DATE: JAN 2023	SCALE: 1:100 @ A1
SHEAR DESIGN REF: 21173	DRAWING NUMBER: 21173-128	REVISION: -	STATUS: P

APPENDIX

iii) BAUDER SYSTEM SUMMARIES

Revision: November 2020 V1

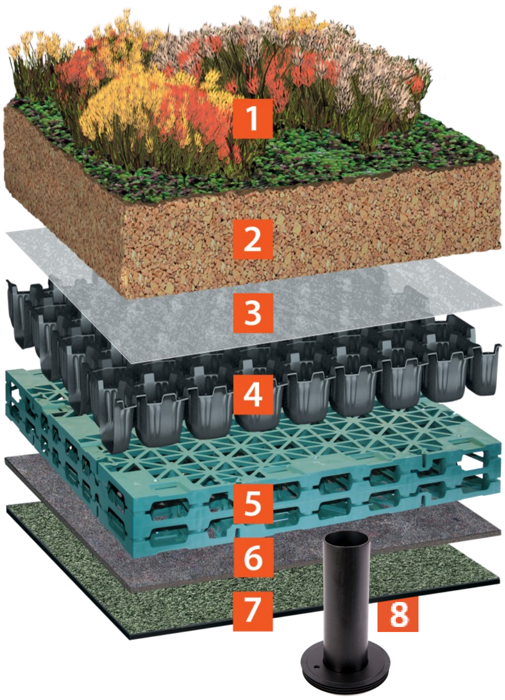
SYSTEM SUMMARY

Bauder Blue Roof - Sedum on substrate system

Green / Blue Roof Solution

Green roofs are an ideal partner for blue roofs as they will naturally delay and reduce rain water run-off from the roof. Green roofs when combined with the blue roof system (Bauder's Attenuation Cell 100) and flow restrictors allow the precise control of the roofs discharge rate and enable large volumes of water to be attenuated at roof level.

A sedum blanket system offers a low maintenance green roof. Laying Bauder's mature SB sedum blanket on a bed of Bauder's extensive substrate gives the system both rooting depth and water retention to make it the most resilient of green roof finishes.



Product	Description	thickness	weight
1 Bauder SB Sedum Blanket *	Typically sown with 17 species of sedums and grown by Bauder for around 12 months before it is harvested.	25mm	24.0Kg/m²
2 Bauder Extensive Substrate	A lightweight, low nutrient growing material tested to BS8616 and manufactured to meet both GRO and FLL guidelines.	80mm	96Kg/m²
3 Bauder Filter Fleece	Filtration layer that prevents substrate fines from washing into the drainage and water storage layer.	1mm	0.125Kg/m²
4 Bauder DSE 20 Drainage Layer	A 20mm drainage board, holding 7.4 ltr/m2. It is manufactured from 100% recycled HDPE.	20mm	8.6Kg/m² (water filled)
5 Attenuation Cell 100	A high strength void element which is 95%+ void. This can hold 95 litres per m2. Allowing it to slowly discharge through the flow restrictor (fitted to the outlet).	100mm	8.06 kg/m2
6 Bauder FSM 600 Protection Layer	Is 100% recycled Polyester and polypropylene fibre mix protection layer to prevent mechanical damage to the underlying waterproofing.	4mm	0.6Kg/m²
7 Underlying Waterproofing System	Bauder's BTGRS Bituminous Membrane or Bauder Hot melt, Bituminous Waterproofing system.	N/A	N/A
8 Bauder Blue Roof Flow Restrictor	A combined restrictor plate and overflow, enabling discharge flow rates to be altered for SUDS requirements.	N/A	N/A
Blue & Green Roof Build up (fully saturated excluding the water held in the Attenuation Cell during a rain event and the underlying waterproofing)		**230mm**	**137Kg/m²**

Note: *Bauder Blue roof systems require bespoke flow rate calculations please contact Bauder's technical department*

*Bauder also produce Wildflower and seeded solutions

When to specify

Where an immediate vegetated finish is required on completion. Bauder SB sedum blanket gives instant ground cover and a low maintenance solution. Ideal for very exposed roof environment.

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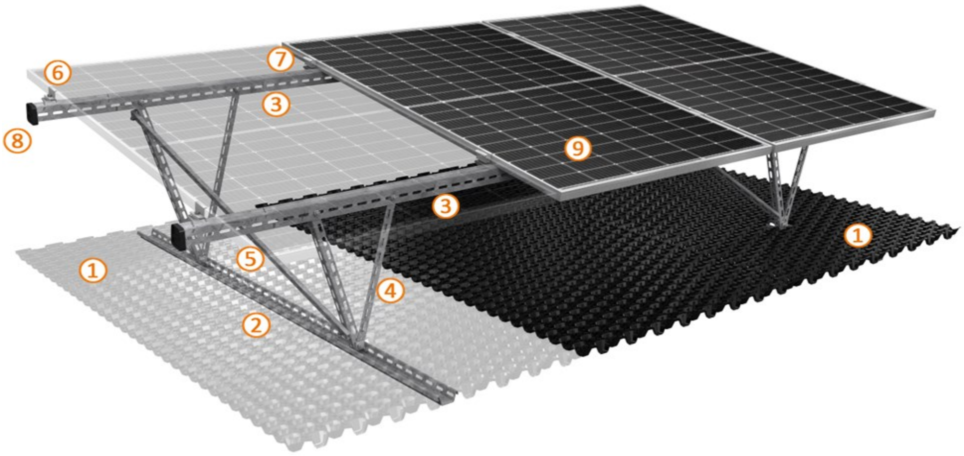
![BAUDER making roofs secure.]

Revision: V2 21/09/2022

SYSTEM SUMMARY BauderSOLAR G LIGHT

Green roof mounting solution for framed solar photovoltaic modules

BauderSOLAR G LIGHT is an integrated solar PV mounting system specifically for Bauder biodiverse or extensive green roofs.



Product	Description	Dimensions (mm)	Weight
1 **BauderSOLAR DSE 40** Anchor board	Modified DSE40 drainage board installed above base rails to ballast the mounting system	1040 x 2030	
2 **BauderSOLAR BS-4 or BauderSOLAR BS-2** Base Rail	Powder coated steel base rail installed on protection layer and beneath DSE40 Anchor board	3994 (BS-4) or 1994 (BS-2) x 36 x 72	
3 **BauderSOLAR MTR** Module carrier rail	Powder coated steel profile rail to support framed solar modules	4700 x 61.9 x 47.5	
4 **BauderSOLAR VT 745** **BauderSOLAR VT 545** V-beams	Pre-assembled V-shaped module carrier rail support manufactured from powder coated steel	L 745 x 399 x 54 S 545 x 343 x 54	
5 **BauderSOLAR DLE** Diagonal profile	Support rail to add rigidity to mounting system—Powder coated steel	1245 x 30 x 15	
6 & 7 **BauderSOLAR MKL (mid) or BauderSOLAR EKL (End)**	Mid and end pre-assembled module clamps	n/a	
8 Module rail end cap	Polypropylene end cap to protect module mounting rail ends	n/a	
9 Solar module	Framed crystalline solar photovoltaic module	Variable	
	Total system weight (kg/m²)*		**176kg/m2**

*Includes weight of Bauder BTRS roof system with 160mm PIR insulation and saturated Biodiverse green roof based on a substrate depth of 100mm

SYSTEM OPTIONS

Solar module options**		
Module	**Efficiency**	**Size**
JAM60S-20-385-MR	20.7%	1052mm x 1769mm
LG Neon H—380Wp	20.4%	1016mm x 1700mm

Recommended planting mix:

Name	Description
Bauder Flora 3 Seed Mix GB50120403	A broad mix of low growing and some shade tolerant species ideal, for most roof environments. Recommend for BioSOLAR installations.

**Bauder BioSolar is a universal mounting system. The listed modules are for reference only, please contact Bauder for advise on project specific module selection.

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APPENDIX

iv) LOADING ASSESSMENT CALCULATIONS – BAUDER ROOF PROPOSAL

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Tel: 029 2054 7000 - Fax: 029 2054 7001 - www.shear-design.com - enquiries@shear-design.com

Contract No:	**21173.D040**
Date:	**Jan 2023**
By:	**MA**

21173 – D040

KINGSTON BRIDGE

RICHMOND - LONDON

STRUCTURAL CALCULATIONS

LOADING ASSESSMENT

DOCUMENT INDEX SHEET

Contract: **Kingston Bridge** Project No: **21173**

Title: Structural Calculations	**Sheets/Page No** 20
Loading Assessment	03 - 18

Date	**Detail of Revision**	**Rev No**
23.01.2023	**First Issue**	**-**

Prepared By:	Mujtaba Ahmed	**Checked By:**	James Spencer	**Authorised By:**	Tony Spencer
Signed:	CEng, MIStructE	**Signed:**	CEng, MICE	**Signed:**	CEng, MICE
Date of Issue:	**23.01.2023**				

LOADING ASSESSMENT

Internal Column

4 Storey Building - Existing Loads (Offices)

	Slab Construction	S.W of Floor	Finishes	Finishes 2	Ceiling Grid	Plaster Board	Services	S.W. of col/wall	Partitions	Imposed	EXISTING LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	0	0.05	0.3	0.1	0	0	0.75	7.65
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0.05	0.3	0.1	0.56	1	2.5	18.18
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0.05	0.3	0.1	0.56	1	2.5	28.71
Existing 1st (Transfer)	150mm THK Slab with Ribs	5.87	0.15	0	0.05	0.3	0.1	0.56	1	2.5	39.24
Existing Ground	Ground Bearing Slab	0	0	0	0	0	0	0.56	0	0	39.8
Foundation								0.56			39.8

4 Storey Building - Proposed Loads (Apartments)

	Slab Construction	S.W of Floor	Finishes	Green Roof	Ceiling Grid	2xFire Board	Services	S.W. of col/wall	Partitions	Imposed	PROPOSED LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	2.75	0	0.25	0.1	0	0	0.75	10.3
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	20.23
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	30.16
Existing 1st (Transfer)	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	40.09
Existing Ground	Ground Bearing Slab	0	0	0	0	0	0	0.56	0	0	40.65
Foundation								0.56			41.2

Edge Column

4 Storey Building - Existing Loads (Offices)

	Slab Construction	S.W of Floor	Finishes	Finishes 2	Ceiling Grid	Plaster Board	Services	S.W. of col/wall	S.W. of Perimeter wall	Cladding	Partitions	Imposed	EXISTING LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	0	0.05	0.3	0.1	0	0	0	0	0.75	7.65
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0.05	0.3	0.1	1.15	1	0.83	1	2.5	20.6
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0.05	0.3	0.1	1.15	1	0.83	1	2.5	33.55
Existing 1st (Transfer)	150mm THK Slab with Ribs	5.87	0.15	0	0.05	0.3	0.1	1.15	1	0.83	1	2.5	46.5
Existing Ground	Ground Bearing Slab	0	0	0	0	0	0	0.5	0	0	0	0	47
Foundation								0.5					47.5

4 Storey Building - Proposed Loads (Apartments)

	Slab Construction	S.W of Floor	Finishes	Green Roof	Ceiling Grid	2xFire Board	Services	S.W. of col/wall	S.W. of Perimeter wall	Cladding	Partitions	Imposed	PROPOSED LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	2.75	0	0.25	0.1	0	0	0	0	0.75	10.3
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	22.65
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	35
Existing 1st (Transfer)	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	47.35
Existing Ground	Ground Bearing Slab	0	0	0	0	0	0	0.5	0	0	0	0	47.85
Foundation								0.5					48.4

Internal Column

7 Storey Building - Existing Loads (Offices)

	Slab Construction	S.W of Floor	Finishes	Finishes 2	MF Ceiling	Plaster Board	Services	S.W. of col/wall	Partitions	Imposed	EXISTING LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	0	0.15	0.3	0.1	0	0	0.75	7.75
Existing 6th	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	0.56	1	2.5	18.38
Existing 5th	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	0.56	1	2.5	29.01
Existing 4th	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	0.56	1	2.5	39.64
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	0.56	1	2.5	50.27
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	0.56	1	2.5	60.9
Existing 1st	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	0.56	1	2.5	71.53
Existing Ground	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	0.56	1	2.5	82.16
Foundation											82.2

7 Storey Building - Proposed Loads (Apartments)

	Slab Construction	S.W of Floor	Finishes	Green Roof	Ceiling	2xFire Board	Services	S.W. of col/wall	Partitions	Imposed	PROPOSED LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	2.75	0	0.25	0.1	0	0	0.75	10.3
Existing 6th	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	20.23
Existing 5th	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	30.16
Existing 4th	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	40.09
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	50.02
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	59.95
Existing 1st	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	69.88
Existing Ground	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	0.56	1	2	79.81
Foundation											0

Edge Column

7 Storey Building - Existing Loads (Offices)

	Slab Construction	S.W of Floor	Finishes	Finishes 2	Ceiling Grid	Plaster Board	Services	S.W. of col/wall	S.W. of Perimeter wall	Cladding	Partitions	Imposed	EXISTING LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	0	0.15	0.3	0.1	0	0	0	0	0.75	7.75
Existing 6th	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	1.15	1	0.83	1	2.5	20.8
Existing 5th	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	1.15	1	0.83	1	2.5	33.85
Existing 4th	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	1.15	1	0.83	1	2.5	46.9
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	1.15	1	0.83	1	2.5	59.95
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	1.15	1	0.83	1	2.5	73
Existing 1st (Transfer)	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	1.15	1	0.83	1	2.5	86.05
Existing Ground	150mm THK Slab with Ribs	5.87	0.15	0	0.15	0.3	0.1	1.15	1	0.83	1	2.5	99.1
Foundation													99.1

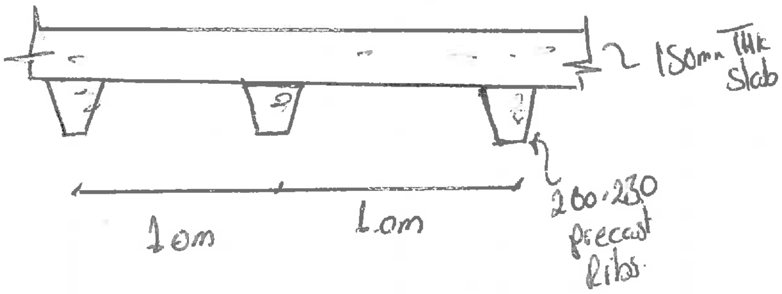
7 Storey Building - Proposed Loads (Apartments)

	Slab Construction	S.W of Floor	Finishes	Green Roof	Ceiling	2xFire Board	Services	S.W. of col/wall	S.W. of Perimeter wall	Cladding	Partitions	Imposed	PROPOSED LOAD
Existing Roof	150mm THK Slab with Ribs	5.87	0.58	2.75	0	0.25	0.1	0	0	0	0	0.75	10.3
Existing 6th	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	22.65
Existing 5th	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	35
Existing 4th	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	47.35
Existing 3rd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	59.7
Existing 2nd	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	72.05
Existing 1st (Transfer)	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	84.4
Existing Ground	150mm THK Slab with Ribs	5.87	0.15	0	0	0.25	0.1	1.15	1	0.83	1	2	96.75
Foundation													0

SHEAR design Consulting Civil and Structural Engineers 7 Ashtree Court · Woodsy Close · Cardiff Gate Business Park · Cardiff · CF23 8RW	Project Title: Kingston Bridge.		Proj. No: 21173
	Element Title: Loading Assessment		Sheet No: 05
	Des'd by: MA	Date: 23.01.23	Chk'd by:	Date:

REF	INPUT	OUTPUT

Roof slab Assessment:



Ⓐ **Loading:**

D.L:

150 mm THK Slab = $24 \times 0.15 = 3.6 \, kN/m^2$

Asphalt (25mm THK) = $0.58 \, kN/m^2$

Bio Solar system (Green Roof with PV) = $2.75 \, kN/m^2$

Ceiling & services = 0.45

Total = 7.38 kN/m^2

L.L:

Roof = $0.75 \, kN/m^2$

ULS:

Ultimate = $1.35 \times 7.38 + 1.5 \times 0.75$

= 10.0 kN.m.

Ⓐ **Forces:**

Moment = $10.5 \times 1^2/8 = 1.5 \, kN\text{-}m/m$

INPUT *Location*

M	kNm/m	1.5	fck	N/mm²	25	γc = 1.50
δ		1.00	fyk	N/mm²	500	γs = 1.15
span	mm	1000	gk	kN/m²	20.00	
h	mm	150	qk	kN/m²	2.50	
Bar Ø	mm	10	Steel class A			
cover, C_{nom}	mm	40	to this steel		Usage Roof	
Δc_{dev}	mm	10			Section location SIMPLY SUPPORTED	
					brittle partitions? NO	

OUTPUT **0.00**

d = 150 - 40 - 10/2 = 105.0 mm

3.1.7 (3) x = [105 - √(105² - 2000/0.85 x 1.5 x 1.5/25)]/0.8 = 1.3 mm

5.5 (4) (x/d) limit = 0.600 x/d actual = 0.012 < 0.600 ok

Fig 3.5 z = 105 - 0.4 x 1.3 = 104.5 > 0.95d = 99.8 mm

As = 1.5E6/500/99.8 x 1.15 = 35 < As min = 140 mm²/m

9.2.1.1 (1) As min = 1.33 x 105 = 140 mm²/m

As def = 35 mm²/m

Provide H10 @ 550 = 143 mm²/m

Table A1.1 EN1990 ψ_2 = 0 (Roof)

SLS udl = 20 + 1 x 2.5 = 22.50 kN/m², n = 20 x 1.35 + 2.5 x 1.5 = 30.75

SLS M = 1.5 x 22.50/30.75 = 1.10 kNm σs = 180.1 N/mm²

7.4.2 (2) Modification factor = 310/180.1 = 1.500(max)

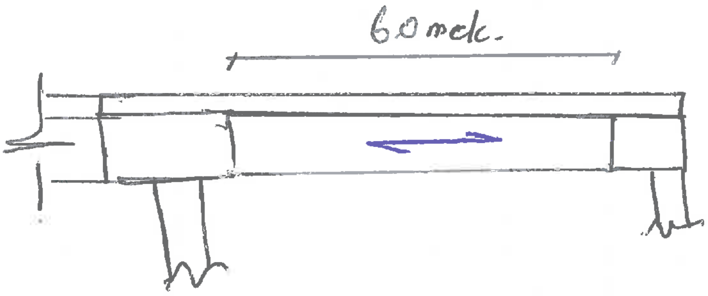
Table 7.4 Permissible L/d = 1.500 x 979.13 = 1,468.70

Actual L/d = 1000/105 = 9.52 ok

SHEAR design Consulting Civil and Structural Engineers 7 Ashtree Court · Woodsy Close · Cardiff Gate Business Park · Cardiff · CF23 8RW	Project Title: Kingston Bridge.	Proj. No: 21173
	Element Title: Loading Assessment	Sheet No: 07
	Des'd by: MA · Date: 28.01.23 · Chk'd by:	Date:

REF	INPUT	OUTPUT

Ribs Assessment to u/s Roofslab:



- Spacing = 1.0 m c/c
- Span = = 6 + d = 6 + 0.25/2 = 6.5m
- Slab UDL (Proposed) = 10.0 kn/m²
- S.W of Ribs = 1.85 × 0.25 × 0.2 × 24 = 1.5 kN/m

Total = 12.5kN/m

Forces

- Bending moment = 12.5 × 6.5²/8 = 66 kNm.
- Shear = 12.5 × ~~6.5~~ × 6/2 = 38 kN — Fails.

percentage Increase:

- D.L + L.L (Existing) = 4.68 kN/m²
- D.L + L.L (Proposed) = 7.38 kN/m²

% = 60%.

Section design to Eurocode 2 (BS EN 1992-1)

RECTANGULAR BEAMS

Originated from TCC11.xls, v 4.3 on CD © 2003-2010 TCC

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08

INPUT

Location 230x200

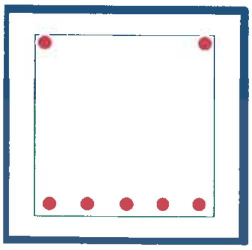
Beam type SIMPLY SUPPORTED

M	kNm	66.0	fck	30	N/mm²	γc = 1.50	
δ		1.00	fyk	500	N/mm²	γs = 1.15	
span	mm	6000	Steel class	A		Δc_{dev}	10
h	mm	230					
b	mm	200					
gk	kN/m	10.00					
qk	kN/m	5.00					
ψ2 =	0	Roof					

REBAR	Ø	COVER
Tension	25	25
Comp'n	16	25
Side	--	25

to main bars

brittle partitions? NO



OUTPUT

230x200 **FAILS on - Deflection . As > 4%. I** sp

Effective depth, d = 230 - 25 - 25/2 = 192.5 mm

Neutral axis, x = [192.5-√(192.5² -2E6x66x1.5/0.85/200/30)]/0.8 = 10000.0 mm

(x/d) limit = 0.600 x/d actual = 51.948 > 0.600, x = 115.5 mm

Lever arm, z = 192.5 - 0.4 x 115.5 = 146.3 mm

d2 = 25 + 16/2 = 33 mm

Gross fsc = 434.8 N/mm² from strain diagram

Net fsc = 434.8 - 0.85 x 30 /1.5 = 417.8 N/mm²

Excess M = 66 - 46.0 = 20.0 kNm

Compression steel, As2 = 20.0E6 /417.8 /(192.5 - 33) = 301 mm²

PROVIDE 2H16 COMPRESSION STEEL = 402 mm²

Steel stress, fyd = 434.8 N/mm² from strain diagram

Tension steel, As = 46.0E6/146.3/434.8 + 300.7 x 417.8/434.8 = 1012 mm²

9.2.1.1 (1) As min = 0.00151 x 200 x 192.5 = 58 mm²

7.3.2 (2) As crack = 0.4 x 1.07 x 2.896 x 21.1/fyk = 52 mm²

7.4.2 As def = 2183 mm²

PROVIDE 5H25 TENSION STEEL = 2454 mm²

DEFLECTION SLS M =66 x 15 /21.0 = 47.1 kNm σs = 173 N/mm²

7.4.2 (2) Modification factor = 310 /172.6 = 1.500(max)

Permissible L/d = 1.500 x 1.000 x 13.982 = 20.97

Actual L/d = 6000 /192.5 = 31.17 **FAILS**

SHEAR design Consulting Civil and Structural Engineers 7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW	Project Title: Kingston Bridge.		Proj. No: 21173
	Element Title: Loading Assessment.		Sheet No: 09
	Des'd by: MA	Date: 23.01.23	Chk'd by:	Date:

REF	INPUT	OUTPUT
	4 ~~St~~storey Building:	
*	Internal Column to u/s 3rd Floor.	
	- Column size = (320 × 720) mm	
	- loaded Area = (7.2 × 6.0) m	
	- Column load = 20.23 × 7.2 × 6 =	875 kN.
		Pass. (min Reinf)
*	Internal Column to Ground Floor.	
	- Column size = (320 × 720) mm	
	- loaded Area = 7.2 × 6.0 m	
	- Column load = 40.65 × 7.2 × 6 =	1756 kN
		Pass. (min Reinf)
*	Edge Column to u/s Roof:	
	- Column size = (250 × 380) mm	
	- loaded Area = (3.6 × 1.5) m^2	
	- Column load = 10.3 × 3.6 × 1.5	= 56 kN
		Pass (min Reinf)
*	Edge column ~~to~~ above Transfer level:	
	- load = 30.16 × 3.6 × 1.5 =	163 kN.
		Pass (min Reinf)
*	Edge column to u/s Transfer (ground) = 40.65 × 3.6 × 6 =	878 kN Pass (min).

Project	KINGSTON	The Concrete Centre		
Client		Made by	Date	Page
Location	INTERNAL COLUMN - 3RD FLOOR	Made by	23-Jan-23	10
	SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO EN 1992-1 : 2004	Checked	Revision	Job No
	Originated from TCC53.xls v4.4 on CD © 2000-23 TCC		-	21173

mpa The Concrete Centre

eurocode

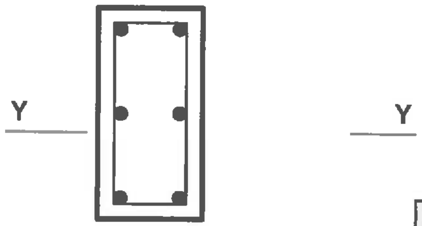
MATERIALS

fck	25	N/mm²	γ_s	1.15	Cover to link, C_{nom}	40	mm
fyk	500	N/mm²	γ_c	1.5	dg	20	mm
ϕ	2.2		ϕef	1.21	$\Delta_{c,dev}$	10	mm
			Steel class	B			

SECTION

h	700	mm
b	320	mm
with	2	bars per 320 face
and	3	bars per 700 face

ie. 700 x 320 columns with 6 bars



RESTRAINTS

	Storey height (mm)	Top Condition	Btm Condition	Braced ?
Y-AXIS	3000	F	P	Y
Z-AXIS	3000	F	P	Y

	L (mm)	L_o (mm)	h_o (mm)
Y-AXIS	2750	2635	220
Z-AXIS	2750	2710	

CONNECTING BEAMS/SLABS

	b (mm)	h (mm)	L (m)	Remote end (F) or (P)
Top West	1000	250	6	P
Top East	1000	250	6	P
Top North	1000	250	4	P
Top South	1000	250	4	P
Bottom West				
Bottom East				
Bottom North				
Bottom South				

Beam stiffnesses are 70% of uncracked stiffness

Column above? Y Col below? Y

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 320 Face	700 Face	Nuz (kN)	Checks
B 40	3.37	10	180	280	5705	ok
B 32	2.15	8	192	286	4794	ok
B 25	1.31	8	199	290	4162	ok
B 20	0.84	8	204	292	3806	ok
B 16	0.54	8	208	294	3578	ok
B 12	0.30	8	212	296	3401	ok

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) m_{0y}	m_{0z}	BTM MOMENTS (kNm) m_{0y}	m_{0z}
1	875				
2					
3					
4					
5					
6					

Moments m_0 at top and bottom of column (from analysis) are combined to find m_{0e}. The moment due to imperfections ($e_1 N$) and the second order moment (M_2) are then added to obtain M_{Ed} in the table below.

DESIGN MOMENTS

	Y AXIS M_{Ed} y	M_{Rd} y	Z AXIS M_{Ed} z	M_{Rd} z	Critical axis	Biaxial Check *Equation (5.39)*	REBAR
1	20.4	288.1	5.8	131.7	Z	0.042	**6 B12**
2						N = 0	
3						N = 0	
4						N = 0	
5						N = 0	
6						N = 0	

SEE CHARTS ON NEXT SHEET

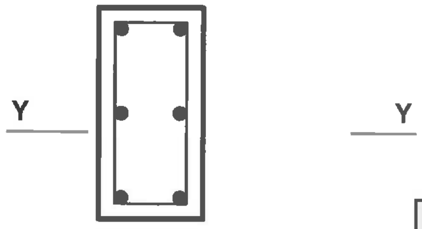
MATERIALS

fck	25	N/mm²	γ_s	1.15	Cover to link, C_{nom}	40	mm
fyk	500	N/mm²	γ_c	1.5	dg	20	mm
ϕ	2.2		ϕef	1.21	$\Delta_{c,dev}$	10	mm
			Steel class	B			

SECTION

h	700	mm
b	320	mm
with	2	bars per 320 face
and	3	bars per 700 face

ie. 700 x 320 columns with 6 bars



RESTRAINTS

	Storey height (mm)	Top Condition	Btm Condition	Braced ?
Y-AXIS	3000	F	P	Y
Z-AXIS	3000	F	P	Y

	L (mm)	L_0 (mm)	h_0 (mm)
Y-AXIS	2750	2635	220
Z-AXIS	2750	2710	

CONNECTING BEAMS/SLABS

	b (mm)	h (mm)	L (m)	Remote end (F) or (P)
Top West	1000	250	6	P
Top East	1000	250	6	P
Top North	1000	250	4	P
Top South	1000	250	4	P
Bottom West				
Bottom East				
Bottom North				
Bottom South				

Beam stiffnesses are 70% of uncracked stiffness

Column above? Y Col below? Y

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 320 Face	700 Face	Nuz (kN)	Checks
B 40	3.37	10	180	280	5705	ok
B 32	2.15	8	192	286	4794	ok
B 25	1.31	8	199	290	4162	ok
B 20	0.84	8	204	292	3806	ok
B 16	0.54	8	208	294	3578	ok
B 12	0.30	8	212	296	3401	ok

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) m_{0y}	m_{0z}	BTM MOMENTS (kNm) m_{0y}	m_{0z}
1	1756				
2					
3					
4					
5					
6					

Moments m_0 at top and bottom of column (from analysis) are combined to find m_{0e}. The moment due to imperfections (e_1N) and the second order moment (M_2) are then added to obtain M_{Ed} in the table below.

DESIGN MOMENTS

	Y AXIS M_{Ed} y	M_{Rd} y	Z AXIS M_{Ed} z	M_{Rd} z	Critical axis	Biaxial Check *Equation (5.39)*	REBAR
1	41.0	322.3	11.6	148.0	Z	0.046	**6 B12**
2						N = 0	
3						N = 0	
4						N = 0	
5						N = 0	
6						N = 0	

SEE CHARTS ON NEXT SHEET

Project	KINGSTON	The Concrete Centre		
Client		Made by	Date	Page
Location	EDGE COLUMN TO U/S ROOF	Made by	23-Jan-23	12
	SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO EN 1992-1 : 2004	Checked	Revision	Job No
eurocode	Originated from TCC53.xls v4.4 on CD © 2000-23 TCC		-	21173

mpa The Concrete Centre

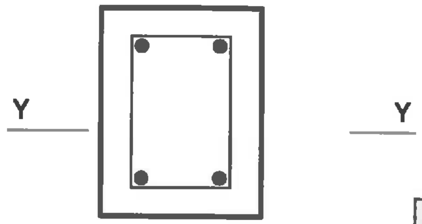
MATERIALS

fck	25	N/mm²	γs	1.15	Cover to link, C_{nom}	40	mm
fyk	500	N/mm²	γc	1.5	dg	20	mm
φ	2.2		φef	1.21	$\Delta_{c,dev}$	10	mm
			Steel class	B			

SECTION

h	350	mm
b	250	mm
with	2	bars per 250 face
and	2	bars per 350 face

ie. 350 x 250 columns with 4 bars



RESTRAINTS

	Storey height (mm)	Top Condition	Btm Condition	Braced ?
Y-AXIS	3000	F	P	Y
Z-AXIS	3000	F	P	Y

	L (mm)	L_0 (mm)	h_0 (mm)
Y-AXIS	2750	2419	146
Z-AXIS	2750	2470	

CONNECTING BEAMS/SLABS

	b (mm)	h (mm)	L (m)	Remote end (F) or (P)
Top West	1000	250	6	P
Top East	1000	250	6	P
Top North	1000	250	4	P
Top South	1000	250	4	P
Bottom West				
Bottom East				
Bottom North				
Bottom South				

Beam stiffnesses are 70% of uncracked stiffness

Column above? Y Col below? Y

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 250 Face	350 Face	Nuz (kN)	Checks
B 32	3.68	8	122	222	2320	ok
B 25	2.24	8	129	229	1899	ok
B 20	1.44	8	134	234	1662	ok
B 16	0.92	8	138	238	1510	ok
B 12	0.52	8	142	242	1392	ok
B 10		8	144	244		As or Ø < minimum

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) m_{0y}	m_{0z}	BTM MOMENTS (kNm) m_{0y}	m_{0z}
1	56				
2					
3					
4					
5					
6					

Moments m_0 at top and bottom of column (from analysis) are combined to find m_{0e}. The moment due to imperfections (e_1N) and the second order moment (M_2) are then added to obtain M_{Ed} in the table below.

DESIGN MOMENTS

	Y AXIS M_{Ed} y	M_{Rd} y	Z AXIS M_{Ed} z	M_{Rd} z	Critical axis	Biaxial Check *Equation (5.39)*	REBAR
1	1.1	35.5	0.3	24.4	Z	0.024	4 B12
2						N = 0	
3						N = 0	
4						N = 0	
5						N = 0	
6						N = 0	

SEE CHARTS ON NEXT SHEET

Project	KINGSTON		The Concrete Centre	
Client				
Location	EDGE COLUMN TO U/S ROOF 2nd	Made by: Made by	Date: 23-Jan-23	Page: 13
	SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO EN 1992-1 : 2004	Checked	Revision: -	Job No: 21173
	Originated from TCC53.xls v4.4 on CD © 2000-23 TCC			

MATERIALS

fck	25	N/mm²	γs	1.15	Cover to link, C_{nom}	40	mm
fyk	500	N/mm²	γc	1.5	dg	20	mm
φ	2.2		φef	1.21	$\Delta_{c,dev}$	10	mm
			Steel class	B			

SECTION

h	350	mm
b	250	mm
with	2	bars per 250 face
and	2	bars per 350 face

ie. 350 x 250 columns with 4 bars

Y Y

RESTRAINTS

	Storey height (mm)	Top Condition	Btm Condition	Braced ?
Y-AXIS	3000	F	P	Y
Z-AXIS	3000	F	P	Y

	L (mm)	L_0 (mm)	h_0 (mm)
Y-AXIS	2750	2419	146
Z-AXIS	2750	2470	

CONNECTING BEAMS/SLABS

	b (mm)	h (mm)	L (m)	Remote end (F) or (P)
Top West	1000	250	6	P
Top East	1000	250	6	P
Top North	1000	250	4	P
Top South	1000	250	4	P
Bottom West				
Bottom East				
Bottom North				
Bottom South				

Beam stiffnesses are 70% of uncracked stiffness

Column above? Y Col below? Y

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 250 Face	350 Face	Nuz (kN)	Checks
B 32	3.68	8	122	222	2320	ok
B 25	2.24	8	129	229	1899	ok
B 20	1.44	8	134	234	1662	ok
B 16	0.92	8	138	238	1510	ok
B 12	0.52	8	142	242	1392	ok
B 10		8	144	244		As or Ø < minimum

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) m_{0y}	m_{0z}	BTM MOMENTS (kNm) m_{0y}	m_{0z}
1	163				
2					
3					
4					
5					
6					

Moments m_0 at top and bottom of column (from analysis) are combined to find m_{0e}. The moment due to imperfections ($e_1 N$) and the second order moment (M_2) are then added to obtain M_{Ed} in the table below.

DESIGN MOMENTS

	Y AXIS M_{Ed} y	M_{Rd} y	Z AXIS M_{Ed} z	M_{Rd} z	Critical axis	Biaxial Check Equation (5.39)	REBAR
1	3.3	48.6	1.0	32.7	Z	0.049	4 B12
2						N = 0	
3						N = 0	
4						N = 0	
5						N = 0	
6						N = 0	

SEE CHARTS ON NEXT SHEET

Project			Th
Client			Mad
Location	EDGE COLUMN TO US 1ST FLOOR (TRANSFER)	mpa The Concrete Centre	M
	CIRCULAR COLUMN DESIGN TO EN 1992-1 : 2004		Chec
eurocode 2	Originated from TCC54.xls v4.1 on CD	© 2004-2023 TCC	

MATERIALS

fck	25	N/mm²	γ_s	1.15	steel	Cover	40	
fyk	500	N/mm²	γ_c	1.5	concrete	dg	20	
ϕ	2.81		ϕ_{ef}	1.43		$\Delta_{c,dev}$	5	
Steel class	A							

DESIGN SECTION

h	375	mm
with	6	bars

RESTRAINTS

L =	3500	mm
Top	P	Pinned
Btm	P	Pinned
Braced	Y	.

CONNECTING BEAM

	b (mm)	h (r
Top left	1000	15
Top right	1000	15
Bottom left	1000	15
Bottom right	1000	15

Beam stiffnesses are 7C

Column above?)

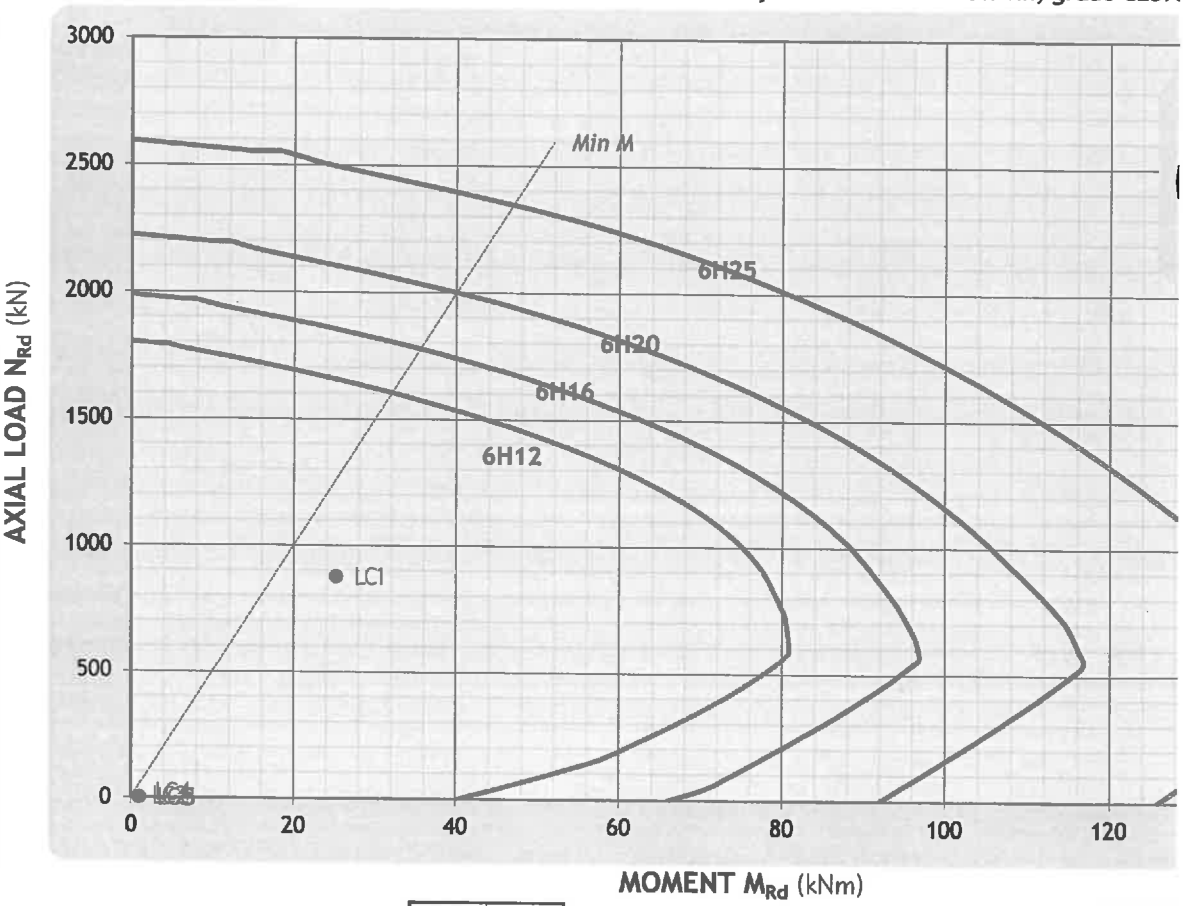
Data on connecting beams only

BAR ARRANGEMENTS

Type	Bar Ø	Asc %	Link Ø	Bar c/c	N_{bal} (kN)	N_{uz} (kN)
H	40	6.83	10	123.0		
H	32	4.37	8	129.3		
H	25	2.67	8	133.0	521.1	2595.5
H	20	1.71	8	135.6	559.5	2224.4
H	16	1.09	8	137.7	561.3	1986.9
H	12	0.61	8	139.8	613.5	1802.2

N:M interaction chart

for 375 diameter column, grade C25/.



LOADCASES

	Loadcase	N_{Ed} (kN)	M_{02} (kNm)	M_{01}	M_{Ed} (kNm)	
	1	878	18	0	25.2	6 H12
moment input	2	1	1	1	1.0	6 H12
ok	3	1	1	1	1.0	6 H12

Loadcase	N_{Ed} (kN)	M_{02} (kN
4	1	1
5	1	1
6	1	1

SHEAR design
Consulting Civil and Structural Engineers
7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW

Project Title: Kingston.			Proj. No: 21173
Element Title: Loading Assessment.			Sheet No: 15
Des'd by: MA	Date: 28.01.23	Chk'd by:	Date:

REF	INPUT	OUTPUT
	Internal RC Beam:	
	- Span = 6 m c/c	
	- Spacing : 7.2 m	
	- ULS = $1.35 \cdot (9.55) + 1.5 \cdot (0.75)$	
	= 14 kN/m²	
	Forces:	
	- Continous Beam (Edge span)	
	Moment = 0.077 F L	
	= $0.077 \times (14 \times 7.2 \times 6) \times 6$ =	280 kN.m
	Shear = $0.6 \times (14 \cdot 7.2 \cdot 6)$ =	360 kN.

INPUT *Location* 1900x380 Beam type END SPAN

M	kNm	280.0	fck	25	N/mm²	γc = 1.50	
δ		1.00	fyk	500	N/mm²	γs = 1.15	
span	mm	6000	Steel class	A		Δc_{dev}	10
h	mm	380					
b	mm	1900					
gk	kN/m	10.00					
qk	kN/m	5.00					
ψ2 =	0	Roof					

REBAR	Ø	COVER
Tension	16	40
Comp'n	20	40
Side	--	40

to main bars

brittle partitions? NO

OUTPUT **1900x380**

Effective depth, d = 380 - 40 - 16/2 = 332.0 mm

Neutral axis, x = [332-√(332² -2E6x280x1.5/0.85/1900/25)]/0.8 = 41.2 mm

(x/d) limit = 0.600 x/d actual = 0.124 ok

Lever arm, z = 332 - 0.4 x 41.2 = 315.5 > 0.95d = 315.4 mm

Tension steel, As = 280.0E6/315.4/434.8 = 2042 mm²

9.2.1.1 (1) As min = 1.3 x 1900 x 380 = 841 mm²

7.3.2 (2) As crack = 0.4 x 0.8 x 3 x 380/2 x 1900/500 = 472 mm²

for deflection, As def = 821 mm²

PROVIDE 11H16 TENSION STEEL = 2212 mm²

Service stress, SLS M =280 x 15 /21.0 = 200.0 kNm ρ = 300 N/mm²

Modification factor = 310 /300.3 = 1.032

Permissible L/d = 1.032 x 1.000 x 45.492 = 46.97

Actual L/d = 6000 /332 = 18.07 ok

BEAM SHEAR

INPUT

Location

fck N/mm² 25 γc = 1.50

fywk N/mm² 500 γs = 1.15

d	bw
320	1900

Main Steel

Ø 16

No 11

Link Ø	Legs	Side cover	VEd	n
10 mm	4 No	50 mm	360.0 kN at face	1 kN/m

OUTPUT

6.2.2 (1)	A_{sL} =	2212 mm² = 0.364%	f_{cd} = 16.7 N/mm²
equation (6.6)	ν =	0.6(1 - 25/250) = 0.540	cotθ = 2.50
equation (6.9)	$V_{Rd,max}$ =	1 x 1900 x 288.0 x 0.540 x 16.7 /2.90 /1000 = 1,698.2 kN	ok
6.2.1 (8)	V_{Ed} @ d =	360 - 1 x 0.32 = 359.7 kN	
6.2.2 (1)	k =	1 + √(200 /320) = 1.791	
equation (6.2)	$V_{Rd,c}$ =	0.12 x 1.791 cube root(0.364 x 25) = 272.7 kN	
9.2.2 (5)	A_{sw}/s (min)=	0.08 x 1900 /500 x √25 = 1.520 mm	
equation (6.9)	A_{sw}/s (max)=	0.5 x 1900 /500 x 1.15 x 0.540 x 16.7 = 19.665 mm	ok
equation (6.7)	A_{sw}/s =	359.7E3 /(288.0 x 434.8 x 2.50) = 1.149 < 1.520	
9.2.2 (6)	$s_{max,L}$ =	240 mm $s_{max,T}$ = 240 mm *9.2.2 (8)*	

PROVIDE 4 legs H10 @ 200

Provide for distance of -11600 mm from support face

then nominal links = 4 legs H10 @ 200

SHEAR design Consulting Civil and Structural Engineers	Project Title: Kingston Bridge	Proj. No: 21173
	Element Title: Loading Assessment.	Sheet No: 18
	Des'd by: MA · Date: 28.01.2013 · Chk'd by:	Date:

REF	INPUT	OUTPUT

Foundation Assessment:

* 4-Storey Building:

Refer to loading table

Load at Foundation level:

(*) Internal
- Existing = 39.8 kN/m²
- Proposed = 41.2 kN/m²
- Increase = 3.5 % < 10% — ok

(*) Edge
- Existing = 47.5 kN/m²
- Proposed = 48.4 kN/m²
- Increase = 1.9% < 10% — ok.

* 7-Storey Building:

Refer to loading table.

(*) Internal.
- Existing = 82.4 kN/m²
- Proposed = 79.84 kN/m²

No Increase

(*) Edge
- Existing = 99.1 kN/m²
- Proposed = 96.75 kN/m²

No Increase.

APPENDIX

v) LOADING ASSESSMENT CALCULATIONS - BALCONY PROPOSAL

SHEAR design
Consulting Civil and Structural Engineers
7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW
Tel: 029 2054 7000 - Fax: 029 2054 7001 - www.shear-design.com - enquiries@shear-design.com

Contract No:	**21173.D041**
Date:	**AUG 2023**
By:	**RM**

21173 – D041

KINGSTON BRIDGE

RICHMOND - LONDON

STRUCTURAL CALCULATIONS

LOADING ASSESSMENT

SHEARdesign
Consulting Civil and Structural Engineers

DOCUMENT INDEX SHEET

Contract: **Kingston Bridge** Project No: **21173**

Title: Structural Calculations	**Sheets/Page No**
Loading Assessment	

Date	**Detail of Revision**	**Rev No**
22.08.2023	**First Issue**	**-**

Prepared By:	Ragy Mohammed	**Checked By:**	Mujtaba Al-Hadadd	**Authorised By:**	Tony Spencer
Signed:		**Signed:**	CEng, MICE	**Signed:**	CEng, MICE
Date of Issue:	**22.08.2023**				

SHEAR design
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Project Title: KINGSTON BRIDGE			Proj. No: 21173
Element Title: LOADING ANALYSIS			Sheet No: BC/01
Des'd by: RM	Date: 18/08/2023	Chk'd by: MA	Date: 22/08/2023

REF	INPUT	OUTPUT

STRUCTURAL LOADING ASSESSMENT

* ASSESSING THE ADDITIONAL LOADING ON THE EXISTING STRUCTURE DUE TO THE PROPOSED BALCONY LOADINGS.

DESIGN DATA

- THE BALCONY HAS A PLAN AREA OF 3.7×1.6 m.
- THE BALCONY TO BE FIXED TO THE EXISTING CONCRETE FRAME THROUGH A COMBINATION OF STEEL CHANNELS AND TIE RODS (STRUTS) ASSUMED TO BE AT A 45° ANGLE.

LOADING

DEAD LOAD:

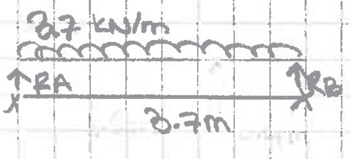
– TIMBER FLOOR DECK	–	0.15 kN/m²
– STEELWORK (MULTIBEAMS)	–	0.50 kN/m²
– FLOOR FINISHES	–	0.20 kN/m²
		0.85 kN/m²

IMPOSED LOAD:

– FLOOR (RESIDENTIAL)	–	1.50 kN/m²
– BALCONY	–	2.50 kN/m²

ANALYSIS

LOADED WIDTH = 1.5 / 2 = 0.75m
UDL = 0.75 × (0.85 + 2.5) = 2.5 kN/m
ULT. UDL = 0.75[(1.35×0.85)+(1.5×2.5)] = 3.7 kN/m

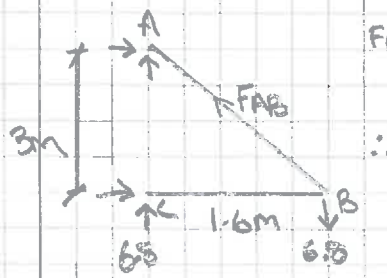


$\Sigma F_V = 0$

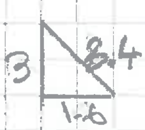
$V_{MAX} = 3.7 \times 3.7 / 2$
$= 6.8$ kN

$M_{MAX} = 3.7 \times 3.7^2 / 8$
$= 6.3$ kNm

COMPUTING MEMBER FORCES:



$F_{AB} = 6.8 \times 3.4 / 3.0$
$= 7.7$ kN TENSION



∴ THE TIE RODS (STRUTS) MUST BE ABLE TO TRANSMIT A TENSILE FORCE OF 7.7 kN. THE RESIN ANCHORE CAPACITIES MUST EXCEED 14.0 kN & 6.8 kN, TENSION AND SHEAR FORCES.

SHEARdesign Consulting Civil and Structural Engineers	Project Title: KINGSTON BRIDGE			Proj. No: 21173
7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW Tel: 029 2054 7000 - Fax 029 2054 7001 - www.shear-design.com - enquiries@shear-design.com	Element Title: FOUNDATION LOADING ASSESSMENT			Sheet No: BC/02
	Des'd by: RM	Date: 18/08/2023	Chk'd by:	Date: 22/08/2023

REF	INPUT	OUTPUT

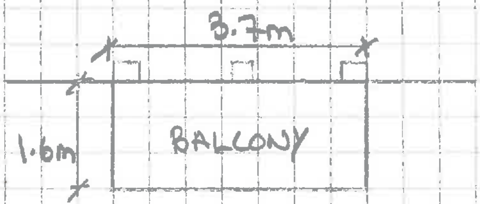
ASSESSING LOAD ON FOUNDATION

* ASSESSING THE ADDITIONAL LOAD ON THE FOUNDATIONS DUE TO THE PROPOSED BALCONIES.

DESIGN DATA

- BALCONY PLAN AREA - 3.7 x 1.6 m
- LOAD ASSUMED TO BE TRANSMITTED TO EDGE SLAB, WHERE IT'S THEN TRANSFERRED TO COLUMNS SPACED @ 1.5m C/C.
- THE INTERNAL COLUMNS ARE POSITIONED CENTRALLY ABOUT THE WIDTH OF THE BLOCK i.e. 7m FROM THE PERIMETER COLUMNS.

LOAD ASSESSMENT



INDICATIVE BALCONY LAYOUT

LOADING:
DEAD LOAD = 0.85 kN/m²
IMPOSED LOAD = 1.5 kN/m²

EQUIVALENT AREA LOAD IS
⇒ (0.85 + 1.5) x 3.7 x 1.6 = 13.9 kN

ASSUME THE LOAD IS SHARED BY TWO COLUMNS
LOAD PER COLUMN = 13.9 / 2 = 7.0 kN

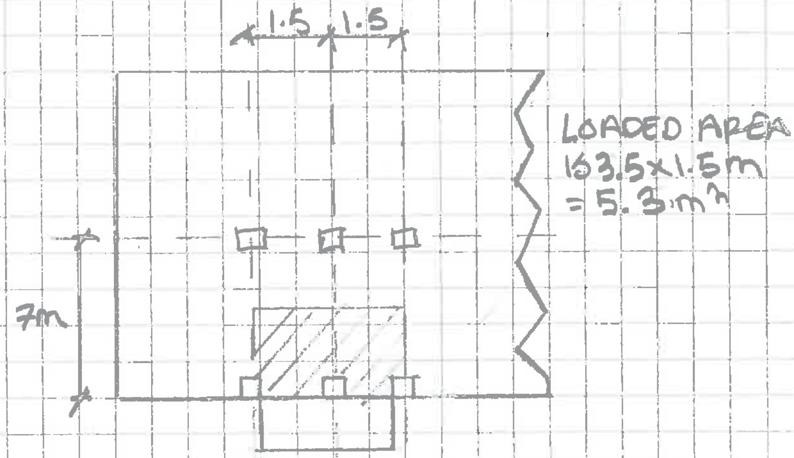
THERE ARE TWO BLOCKS WITH VARYING NO. STORIES
① 4 - STOREY BLOCK
TOTAL ADDITIONAL LOAD IS
⇒ 3 x 7 = 21 kN

② 7 - STOREY BLOCK
TOTAL ADDITIONAL LOAD IS
⇒ 6 x 7 = 42 kN

SHEAR design — Consulting Civil and Structural Engineers	Project Title: KINGSTON BRIDGE			Proj. No: 21173
7 Ashtree Court - Woodsy Close - Cardiff Gate Business Park - Cardiff - CF23 8RW. Tel: 029 2054 7000 - Fax: 029 2054 7001 - www.shear-design.com - enquiries@shear-design.com	Element Title: FOUNDATION LOADING ASSESSMENT			Sheet No: BC/08
	Des'd by: RM	Date: 18/08/2023	Chk'd by: MA	Date: 22/08/2023

REF	INPUT	OUTPUT

ASSESSING LOADING ON FOUNDATIONS



PLAN VIEW

*THE SHADED REGION ABOVE INDICATES THE AREA LOAD TO BE TAKEN BY THE PERIMETER COLUMNS AND SUBSEQUENTLY THE SUPPORTING FOUNDATIONS.

THE TOTAL AREA LOAD FOR BOTH BLOCKS HAS BEEN DETERMINED PREVIOUSLY AS PART OF THE ADDITIONAL GREEN ROOF LOADING ASSESSMENT.

LOADING ASSESSMENT PAGE 1

4-STOREY BLOCK:

TOTAL AREA LOAD (INCL. ALL STORIES) = 48.4 kN/m²

LOAD ON COLUMN = 48.2 x 5.3
= 256 kN

ADDITIONAL LOAD = 21 kN

PROPOSED LOAD = 256 + 21
= 277 kN

∴ THE ADDITIONAL LOAD DUE TO THE PROPOSED BALCONY IMPOSES AN INCREASE OF 8.2% ON THE FOUNDATIONS, WHICH IS DEEMED ACCEPTABLE AS FOUNDATION LOADS MAY BE INCREASED TO 10% WITHOUT EXPERIENCING UNACCEPTABLE SETTLEMENT.

7-STOREY BLOCK:

TOTAL AREA LOAD = 99.1 kN/m²

LOAD ON COLUMN = 99.1 x 5.3 = 525 kN

ADDITIONAL LOAD = 42 kN

PROPOSED LOAD = 525 + 42 = 567 kN

∴ ACCEPTABLE AS INCREASE IS ONLY 8%.

Project		The Concrete Centre		
Client		Made by	Date	Page
Location		Made by	22-Aug-23	BC/04
		Checked	Revision	Job No
		RM	-	21173

mpa The Concrete Centre

SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES
TO EN 1992-1 : 2004

eurocode

Originated from TCC53.xls v4.4 on CD © 2000-23 TCC

MATERIALS

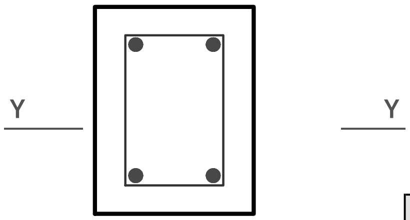
fck	25	N/mm²	γ_s	1.15	Cover to link, C_{nom}	40	mm
fyk	500	N/mm²	γ_c	1.5	dg	20	mm
φ	2.2		φ_{ef}	1.21	$\Delta_{c,dev}$	10	mm

SECTION

Steel class B

h	350	mm
b	250	mm
with	2	bars per 250 face
and	2	bars per 350 face

ie. 350 x 250 columns with 4 bars



RESTRAINTS

	Storey height (mm)	Top Condition	Btm Condition	Braced ?
Y-AXIS	3000	F	P	Y
Z-AXIS	3000	F	P	Y

	L (mm)	L_0 (mm)	h_0 (mm)
Y-AXIS	2750	2419	146
Z-AXIS	2750	2470	

CONNECTING BEAMS/SLABS

	b (mm)	h (mm)	L (m)	Remote end (F) or (P)
Top West	1000	250	6	P
Top East	1000	250	6	P
Top North	1000	250	4	P
Top South	1000	250	4	P
Bottom West				
Bottom East				
Bottom North				
Bottom South				

Beam stiffnesses are 70% of uncracked stiffness

Column above? Y Col below? Y

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 250 Face	350 Face	Nuz (kN)	Checks
B 32	3.68	8	122	222	2320	ok
B 25	2.24	8	129	229	1899	ok
B 20	1.44	8	134	234	1662	ok
B 16	0.92	8	138	238	1510	ok
B 12	0.52	8	142	242	1392	ok
B 10		8	144	244		As or Ø < minimum

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) m_{0y}	m_{0z}	BTM MOMENTS (kNm) m_{0y}	m_{0z}
1	62				
2					
3					
4					
5					
6					

Moments m_0 at top and bottom of column (from analysis) are combined to find m_{0e}. The moment due to imperfections (e_1N) and the second order moment (M_2) are then added to obtain M_{Ed} In the table below.

DESIGN MOMENTS

	Y AXIS M_{Ed} y	M_{Rd} y	Z AXIS M_{Ed} z	M_{Rd} z	Critical axis	Biaxial Check *Equation (5.39)*	REBAR
1	1.2	36.3	0.4	24.9	Z	0.026	4 B12
2						N = 0	
3						N = 0	
4						N = 0	
5						N = 0	
6						N = 0	

SEE CHARTS ON NEXT SHEET

APPENDIX

vi) CONCEPTUAL BALCONY DRAWINGS

ArcelorMittal Construction

ArcelorMittal

April 2021

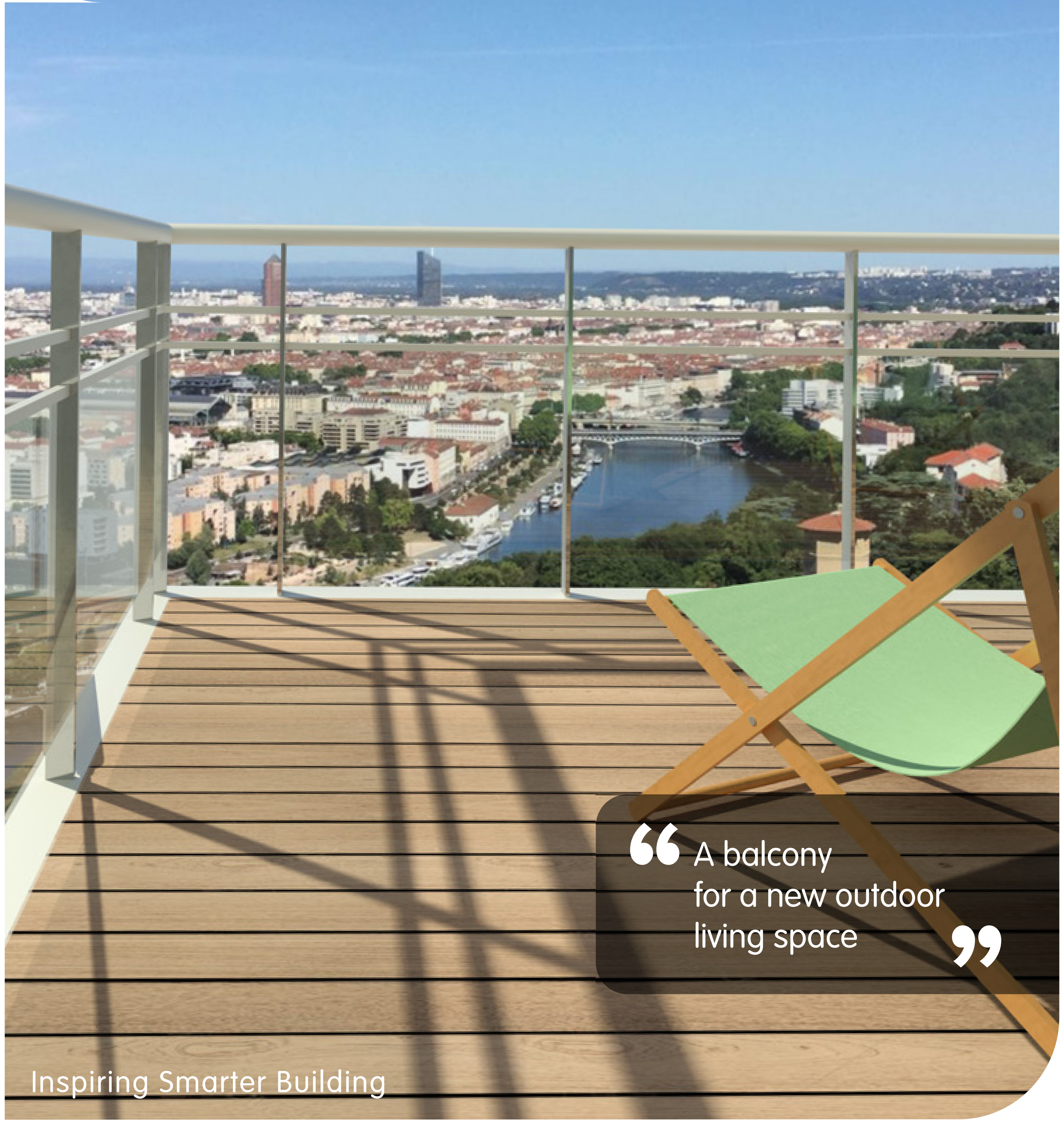
construction.arcelormittal.com

Inventing smarter steels
for a better world

ArcelorMittal Construction

ArcelorMittal

D2B® Canopee



“A balcony
for a new outdoor
living space”

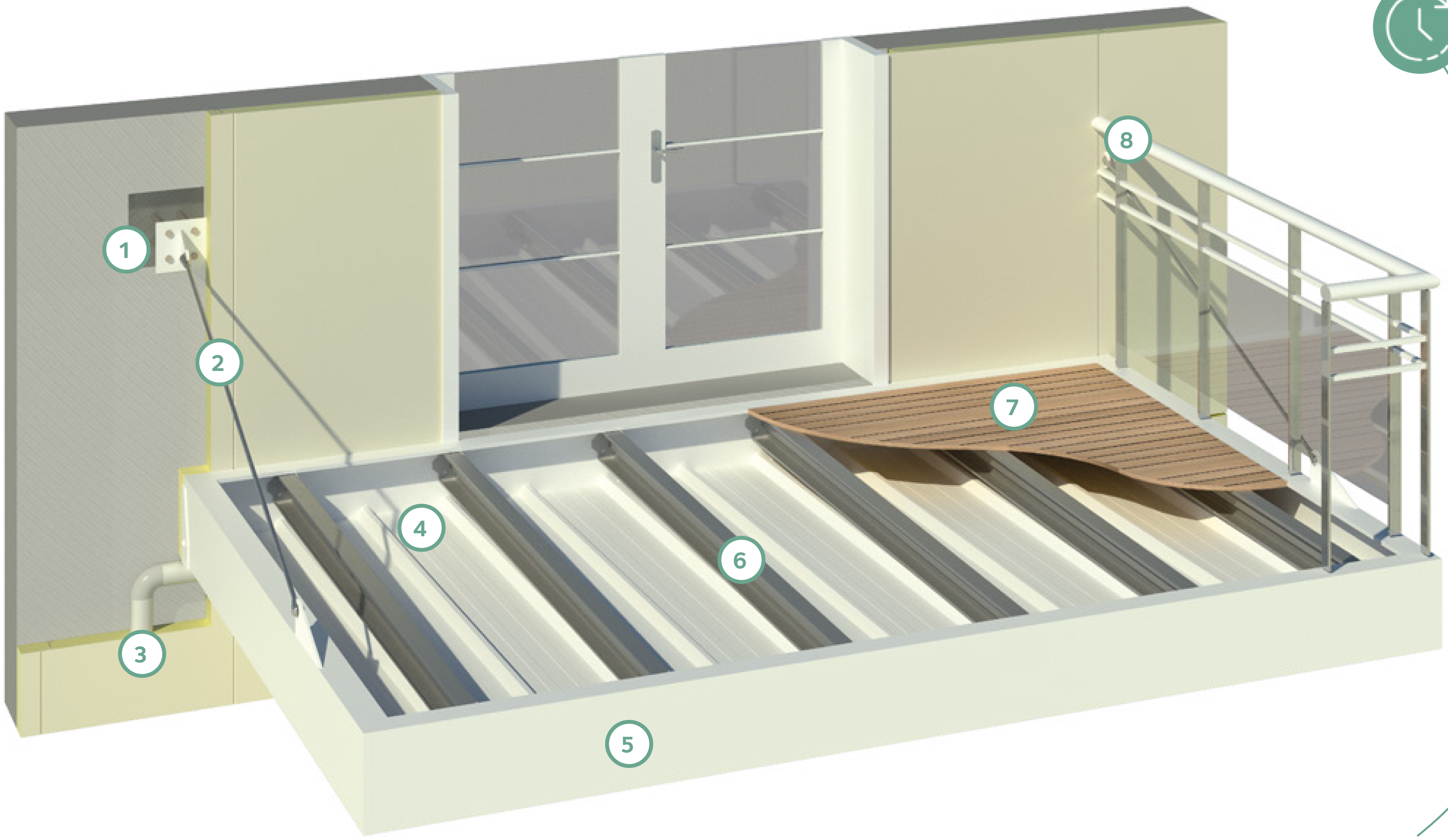
Inspiring Smarter Building

D2B® Canopee

Prefabricated lightweight balcony system

The presence of a balcony or terrace is certainly one of the most sought-after features when it comes to adding value to a property. Having an outdoor space has become an essential part of modern-day living. The larger the terrace, the higher the value it will add.

ArcelorMittal Construction is proud to be able to offer a new range of outdoor spaces with the launch of D2B® Canopee, a new lightweight prefabricated balcony system allowing for quick installation at new-build residences and as part of the rehabilitation of occupied sites.



1 Top plate
2 Stainless steel tie rod
3 Rainwater drainage
4 Fireproof panel
5 Galvanised pre-painted UPE frame
6 Magnelis® multibeam
7 Wooden decking
8 Guardrail

A modern aerial design for a breathtaking view

The balconies are attached to the façade by a series of stainless steel tie rods positioned behind the guardrail. The underside of the balcony, visible from the lower floors, is made of highly durable pre-painted steel. Available in a wide variety of colours. Thanks to its lightweight design, the D2B® Canopee can be used to create terraces up to 3m in depth and 6m in length.

Quick and easy installation

Thanks to this new ultra-light prefabricated design, the installation does not require any foundations or ground-intrusive frameworks. The system allows for the easy installation of the guardrails chosen by the architect, which will be mounted on the ground before the finished balcony is lifted by means of the rings provided for this purpose and attached to its final attachment points.

Accessibility for people with reduced mobility

The D2B® Canopee is designed to meet accessibility requirements with a maximum threshold projection of 20mm, in accordance with the regulations in force.

Fire stability

Our balcony-terraces can be used with up to fourth family buildings. The non-combustible structural components are all A2-s1,d0 classified (EN 13501-1).

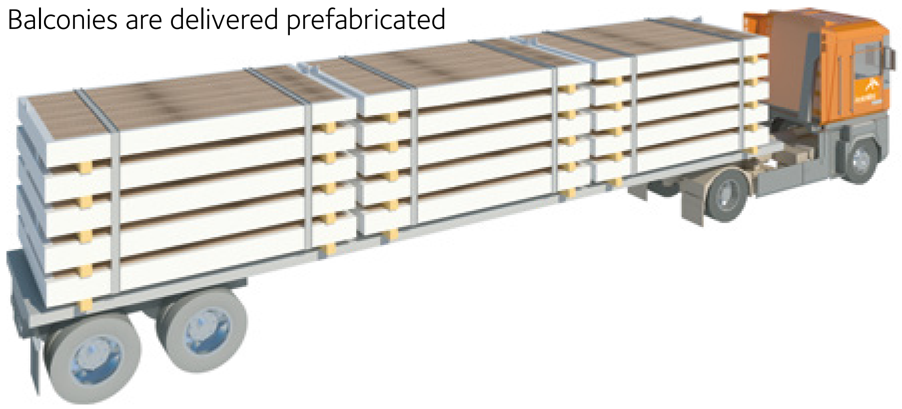
Rainwater runoff

The D2B® Canopee ensures the waterproofing of the terrace and invisibly incorporates a rainwater drainage system via vertical collectors. Rainwater collection is therefore a possibility.

A safer, more sustainable world

In order to reduce the environmental footprint of your buildings, we offer a balcony solution that has no impact on the thermal calculation of the ensemble, with a self-stable hot-dip galvanised steel framework guaranteed for 20 years and made from entirely recycled steel. The terrace is finished with wooden decking from sustainable and certified forest management.

Balconies are delivered prefabricated



Installation