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ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE

THE INSTITUTION OF ENGINEERS, SINGAPORE

Our ref : APPBCA-2019-07
Date : 05/07/2019

Building Engineering Group (#12-01)
Tel : 1800 342 5222

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Dear Sir/Madam,

JOINT BCA / ACES / IES CIRCULAR 2019

GUIDE ON THE FORMAT OF SUBMISSION FOR STRUCTURAL PLANS

Objective

This circular aims to provide a guide on the format of structural plan submissions for Qualified Persons (QPs) and Accredited Checkers (ACs).

Background

2 Regulation 9 of the Building Control Regulations 2003 sets out the particulars to be shown on detailed structural plans and design calculations. In collaboration with ACES/IES, BCA has developed a guide on the format of structural plan submissions.

Guide on Format of Submission

3 The guide (refer Annexes A1, A2 and B) has been developed based on industry's comments and good practices from plan submissions. The templates in Annexes A1 and A2 provide a systematic listing of the structural elements for QPs and ACs to identify the structural elements designed/checked in their submissions. Annex B provides a guide on what could be included in design calculations which helps to clearly demonstrate the design of structural elements in a building.

4 To speed up the preparation of Annex A1 to list the structural elements designed and checked, QPs and ACs are advised to use the recommended design workflow involving data exchange between the structural analysis and design model and the BIM model as given in Annex C. This workflow is intended to allow for a more automated process of listing out the summary of structural elements. We will be organising briefing sessions to share on the proposed format of submission and the recommended design workflow. More details will be provided via Corenet at a later date.

5 Notwithstanding the contents and objective of this circular, ACs continue to have a non-delegable duty under Section 7 of Building Control (AC and ACO) Regulations to review the structural design in the plans of building works and perform their original calculations.

6 Please disseminate the contents of this letter to your members.

For Clarification

7 Please contact Mr. Tan Yu Jun at tel 1800 342 5222 or submit your enquiry through BCA's Online Feedback Form at https://www.bca.gov.sg/feedbackform/, if you need any clarification. Thank you.

Yours faithfully

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Annex A1

Summary for Design and Checking of Structural Elements
[to be submitted together by QP and AC]

Project Ref. No. : _____ ST Ref No. : _____

Project Description: _____

_____

_____

Summary of Structural Elements Sheet
AC should ensure that he has checked all the key structural elements.

S/N	Type of structural elements*	Element markings in structural plan	QP		AC[1]	
			Design Calculations[2]			
			Element markings[3]	Page numbers	Element markings[3]	Page numbers
1	*Footing*	*F1 to F4, F4a, F5 to F7*	*Same as plan*	*5-15*	*Same as plan*	*5 – 18*
2	*Level 1 Beams*	*1B1 to 1B10*	*A-1 to A-10*	*16-30*	*Same as plan*	*19 - 39*
3	*Level 2 Beams*	*2B1 to 2B5, 2B6 (transfer), 2B7 to 2B10*	*A-11 to A-20*	*Refer to Level 1 Beams*	*Same as plan*	*40 – 60*
4	*Typical Floor Beams*	*3B1 to 3B10, 4B1 to 4B10*	*A-21 to A-40*	*31-55*	*Same as plan*	*61 – 90*
5	*Columns*	*1C1 to 1C8, 2C1 to 2C8, 2C9 to 2C10 (transfer), 3C1 to 3C10*	*Same as plan*	*56-71*	*C1 – C28*	*91-115*
6	*Slabs*	*S1 – S10*	*Same as plan*	*72-90*	*NA*	*NA*
7	*Steel Connections*	*Details A - G*	*Same as plan*	*91-101*	*Same as plan*	*116-126*

Annex A1

S/N	Type of structural elements*	Element markings in structural plan	QP		AC[1]	
			Design Calculations[2]			
			Element markings[3]	Page numbers	Element markings[3]	Page numbers

** All structural elements in the project to be designed/checked, e.g. piles/ earth retaining structures/ retaining walls/ columns/ walls/ beams/ slabs/staircase/barrier.*

_____ Stamp & Signature of Qualified Person

_____ Stamp & Signature of Accredited Checker

[1] AC to indicate 'NA" for elements not checked for under his scope.

[2] Design calculations shall be as defined in Building Control Regulations Section 9.

[3] Where QP/AC indicates element markings in design calculations as "same as plan" or equivalent, all the structural elements listed under "Element markings in structural plan" shall be deemed to be designed and checked by QP/AC.

Summary for Design and Checking of Structural Elements
[to be submitted by QP and AC separately]

Project Ref. No. : _____ ST Ref No. : _____

Project Description: _____

_____

_____

Grouping of Structural Elements Sheet

S/N	Type of structural elements*	Element markings in structural plan	Designed structural elements that are similar	Remarks
1	*Beam* *or* *N.A.*	*3B1, 3B2, 3B3, 3B4, 3B5* *or* *N.A.*	*2B1, 2B2, 2B3, 2B4, 2B5* *or* *[to indicate N.A. if there is no grouping in the design]*	*Typical floor*

** All structural elements in the project to be designed/checked, e.g. piles/ earth retaining structures/ retaining walls/ columns/ walls/ beams/ slabs/staircase/barrier.*

_____
Stamp & Signature of Qualified Person/ Accredited Checker

Annex B

Format of design calculations and essential information to include

(1) Design calculations should be in **PDF format** that is able to allow searching base on key words

(2) For the **Structural Summary Sheet**, to provide a **synopsis of the structural design** giving –

(i) a general description of the foundation and structural system and the basic anatomy of stability by which the applied loads are transferred to the ground; and

(ii) design method, assumptions, codes used and limitations of stresses and deformation

(3) For the analysis software used, it should include

- Design input data with computer-generated graphics or hand sketch showing the framing & layout of the structure, location of nodes & elements, joint fixity, element section assignments (refer to Figures 1 to 3), loadings (refer to Figures 5 & 6), materials, etc.
- the **floor layouts with markings of all structural elements** (refer to Figure 4)
- **summary of salient output results (including pictorial illustrations)** e.g. the design envelopes of moment, shear, displacement of the most critical cases for the design and check of the applied forces against the output overall reaction (refer to Figures 7 to 12)
- the interpretation and application of the computer output in the design;

(4) Essential information on the design to resist wind load, including–

- a general description of the **wind-resisting system** and mathematical modelling;
- diagrams illustrating the location and identification of **all structural frames and members** in the wind-resisting system;
- principal reactions (moments, shear forces and axial forces) in the wind-resisting elements; and
- a summary of equilibrium checks on applied lateral forces and calculated reactions of vertical structural members at foundation and other critical levels where there is a major change in structural configuration

(5) Essential information on the design to resist dead and imposed loads, including–

- the **design data on dead and imposed loads** (including allowance for partitions, screeds, dynamic effects and the like); and
- a **summary of principal reactions** (moments, shear forces and axial forces) in vertical structural members at foundation and all floor levels;
- Details of the **design of major transfer members** where the failure of which would induce cumulative instability; and
- **Details of the design of cantilevered canopies, balconies and major structural appendages**

Examples of framing and layout of the structure in Design Calculations

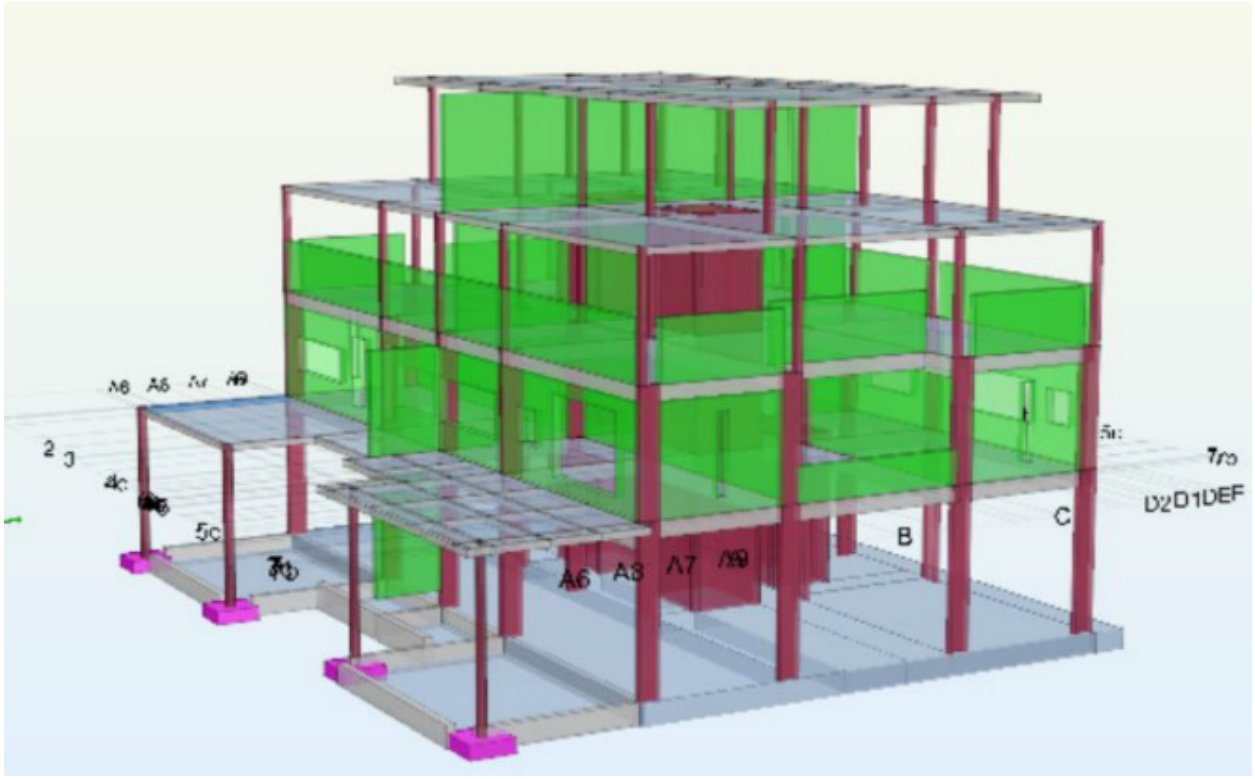


Fig. 1 - 3D illustration of analysis model

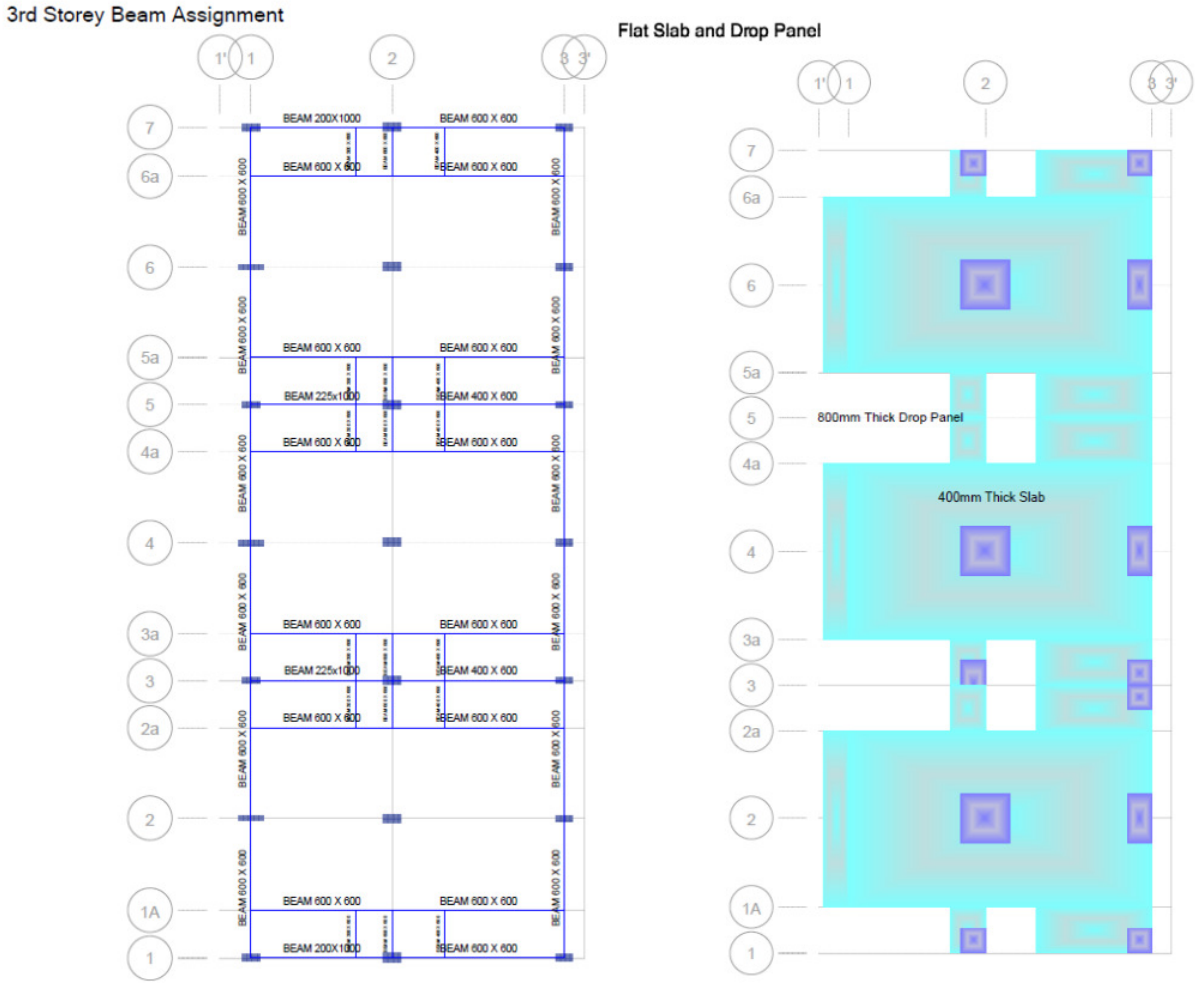


Fig. 2 - Plan layout with beam/slab section properties in design calculations

COLUMN PROPERY ASSIGNMENT

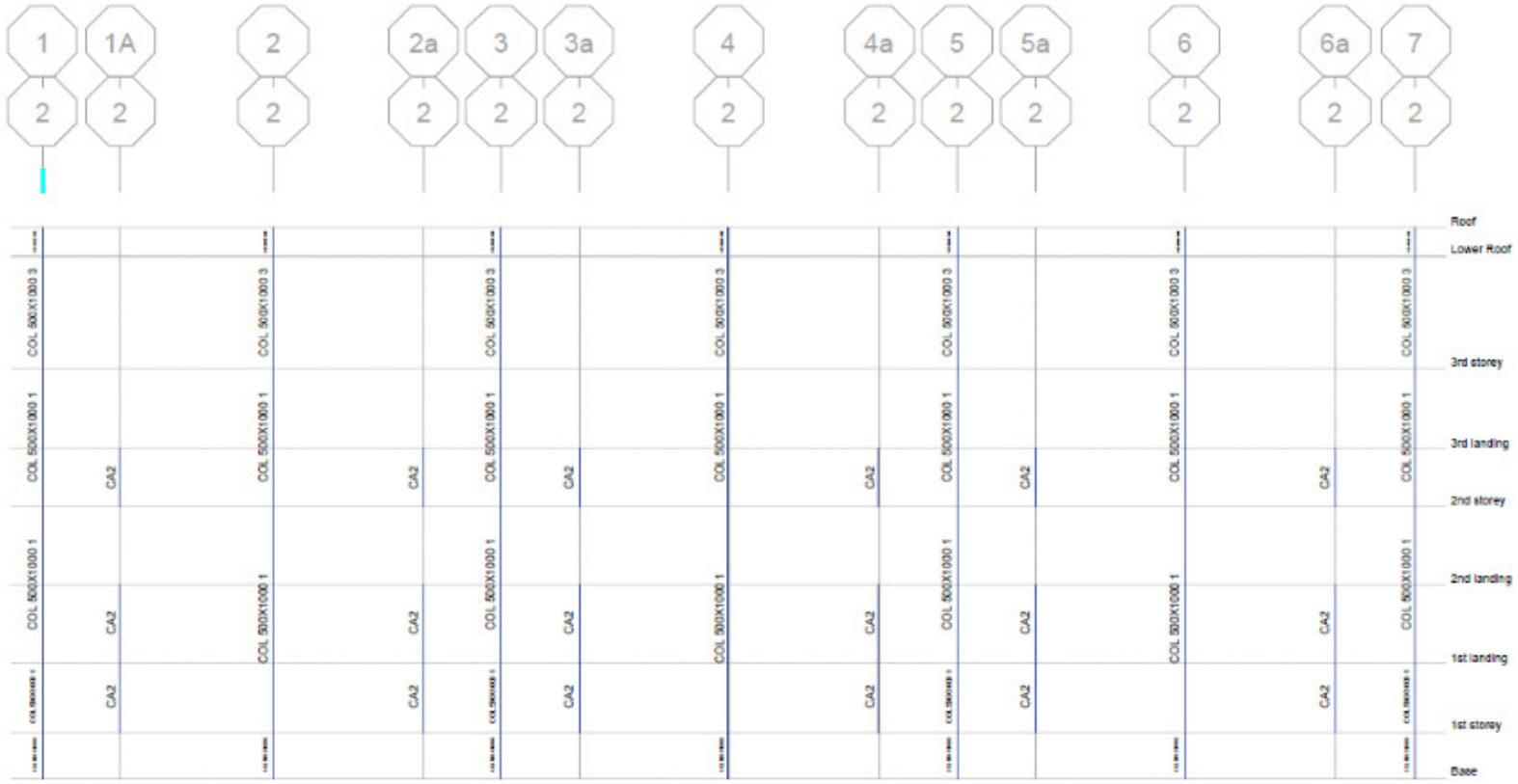


Fig. 3 - Elevation with column section properties in design calculations

Example of presentation of element markings in Design Calculations if they are different from plan

To show in Design calculation

Shown in Structural plan

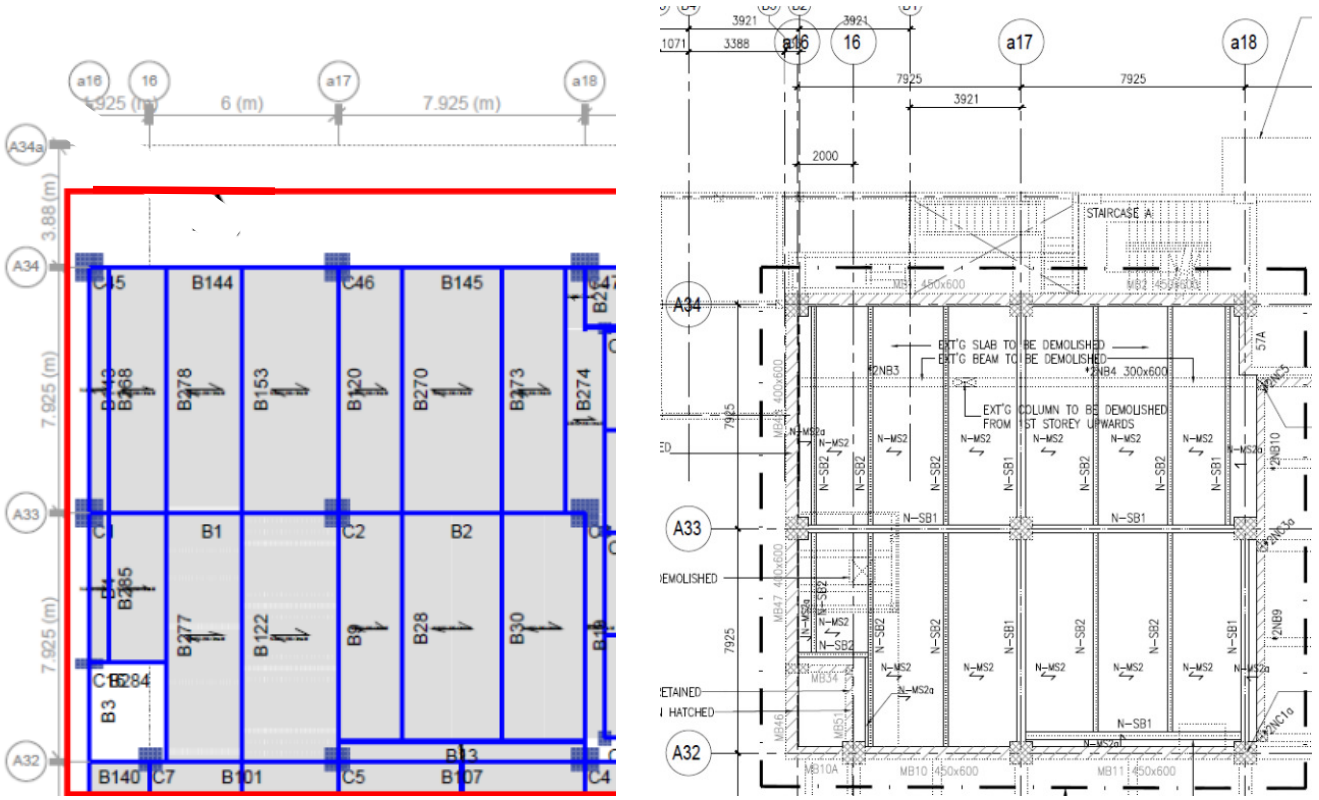


Fig. 4 - Beam layout in design calculation and structural plan

Examples to show load inputs clearly in Design Calculations

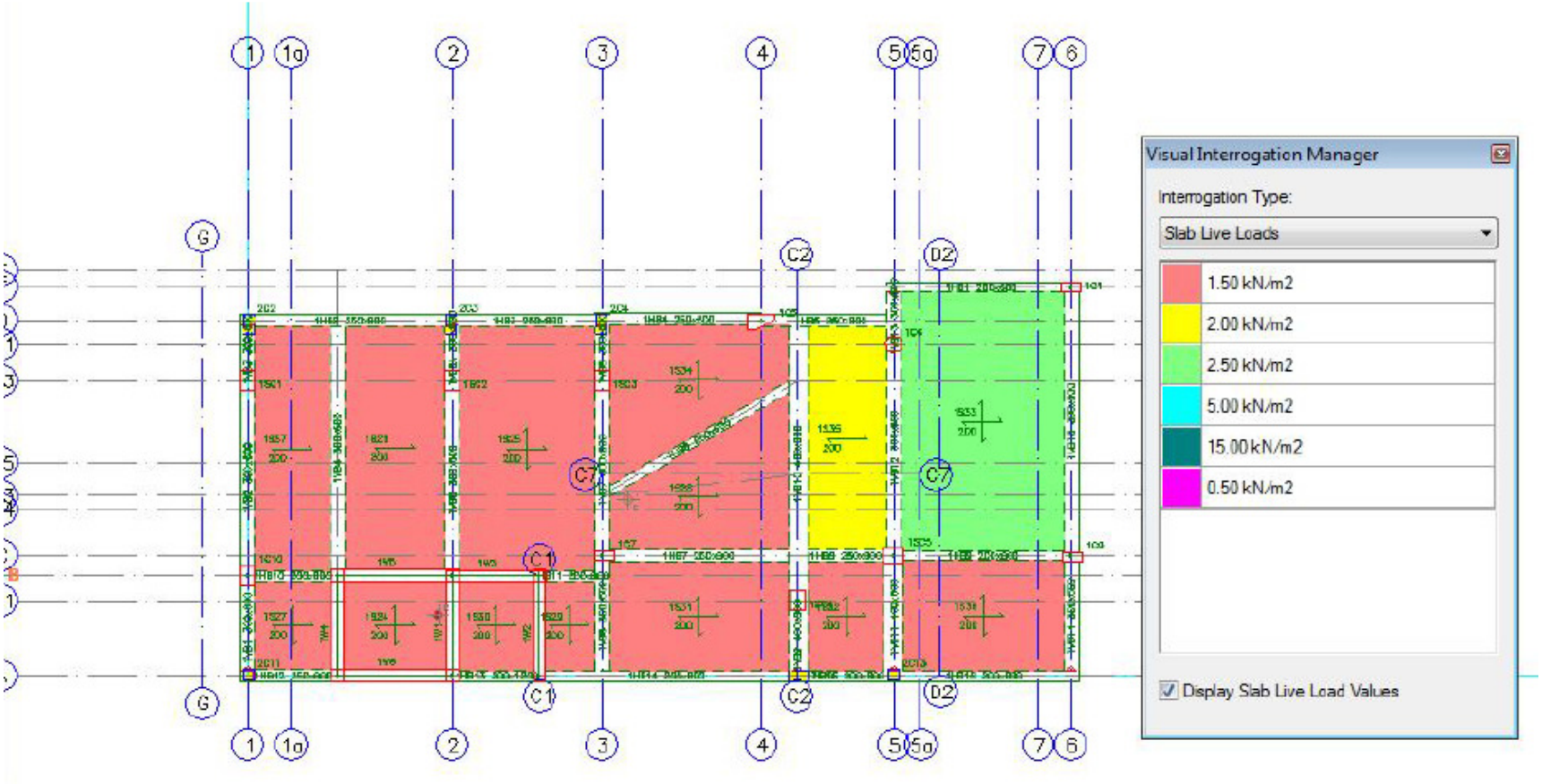


Fig. 5 - Visual representation of loadings on slabs

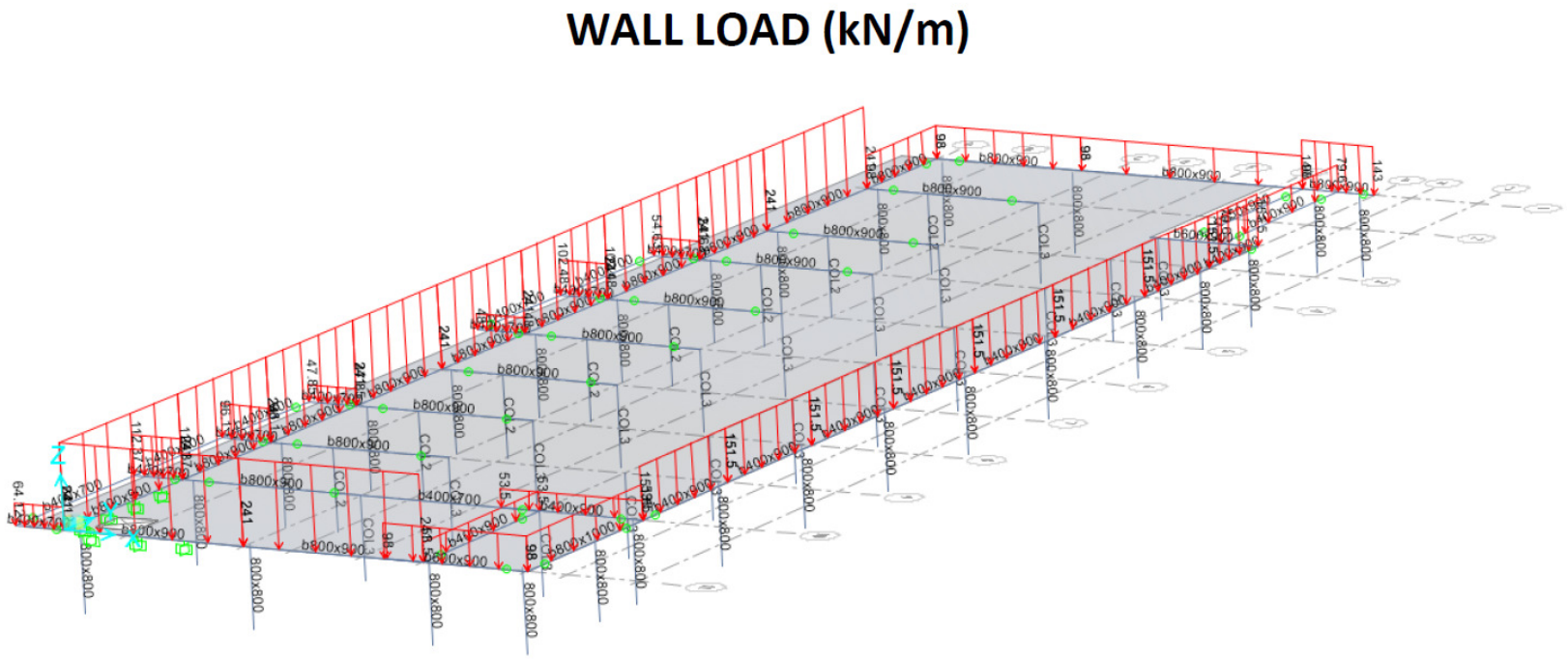


Fig. 6 - Visual representation of loadings on beams

Examples of Summary of salient output results (including pictorial illustrations)

B11 - A end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-125.8	-2.7	-113.6	-31.1	-10.1	26.9	Load combination-1
Compression	-125.8	-2.7	-113.6	-31.1	-10.1	26.9	Load combination-1
Torsion - Mx	-104.1	-3.5	-138.9	-28.1	-9.2	38.6	Load combination-23
Bending - My	-104.1	-3.5	-138.9	-28.1	-9.2	38.6	Load combination-23
Bending - Mz	-91.5	-3.0	-59.7	-33.3	-11.1	8.3	Load combination-11
Shear - Vy	-91.5	-3.0	-59.7	-33.3	-11.1	8.3	Load combination-11
Shear - Vz	-104.1	-3.5	-138.9	-28.1	-9.2	38.6	Load combination-23

B11 - B end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-106.4	-2.7	2.1	12.9	-10.1	26.9	Load combination-1
Compression	-106.4	-2.7	2.1	12.9	-10.1	26.9	Load combination-1
Torsion - Mx	-72.2	-3.6	0.0	14.8	-11.0	23.3	Load combination-11
Bending - My	-76.5	-2.6	2.4	11.7	-9.1	26.6	Load combination-25
Bending - Mz	-72.2	-3.6	0.0	14.8	-11.0	23.3	Load combination-11
Shear - Vy	-72.2	-3.6	0.0	14.8	-11.0	23.3	Load combination-11
Shear - Vz	-100.9	-3.0	2.4	12.4	-9.8	29.1	Load combination-8

B12 - A end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-525.9	-24.1	0.0	0.0	-29.0	236.7	Load combination-6
Compression	-525.9	-24.1	0.0	0.0	-29.0	236.7	Load combination-6
Torsion - Mx	-524.7	-24.9	0.0	0.0	-30.6	248.8	Load combination-4
Shear - Vy	-487.2	-22.9	0.0	0.0	-33.2	229.3	Load combination-15
Shear - Vz	-510.6	-22.9	0.0	0.0	-13.2	264.5	Load combination-3

B12 - B end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-524.5	-24.1	71.0	8.7	-29.0	236.7	Load combination-6
Compression	-524.5	-24.1	71.0	8.7	-29.0	236.7	Load combination-6
Torsion - Mx	-523.4	-24.9	74.6	9.2	-30.6	248.8	Load combination-4
Bending - My	-509.2	-22.9	79.3	4.0	-13.2	264.5	Load combination-3
Bending - Mz	-485.8	-22.9	68.8	10.0	-33.2	229.3	Load combination-15
Shear - Vy	-485.8	-22.9	68.8	10.0	-33.2	229.3	Load combination-15
Shear - Vz	-509.2	-22.9	79.3	4.0	-13.2	264.5	Load combination-3

B13 - A end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-526.4	27.0	0.0	0.0	29.9	-247.0	Load combination-2
Compression	-526.4	27.0	0.0	0.0	29.9	-247.0	Load combination-2
Torsion - Mx	-526.2	29.9	0.0	0.0	45.3	-261.9	Load combination-4
Shear - Vy	-488.9	28.8	0.0	0.0	45.6	-243.4	Load combination-15
Shear - Vz	-511.4	25.6	0.0	0.0	43.6	-272.6	Load combination-7

B13 - B end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-525.0	27.0	-74.1	-9.0	29.9	-247.0	Load combination-2
Compression	-525.0	27.0	-74.1	-9.0	29.9	-247.0	Load combination-2
Torsion - Mx	-524.8	29.9	-78.6	-13.6	45.3	-261.9	Load combination-4
Bending - My	-510.0	25.6	-81.7	-13.1	43.6	-272.6	Load combination-7
Bending - Mz	-487.5	28.8	-73.0	-13.7	45.6	-243.4	Load combination-15
Shear - Vy	-487.5	28.8	-73.0	-13.7	45.6	-243.4	Load combination-15
Shear - Vz	-510.0	25.6	-81.7	-13.1	43.6	-272.6	Load combination-7

B15 - A end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-43.5	0.0	29.9	0.1	0.0	-87.2	Load combination-19
Compression	-43.5	0.0	29.9	0.1	0.0	-87.2	Load combination-19
Bending - My	-43.5	0.0	29.9	0.1	0.0	-87.2	Load combination-19
Bending - Mz	-39.3	0.0	26.0	-0.5	-0.1	-61.8	Load combination-13
Shear - Vy	-37.6	0.0	25.6	-0.3	-0.2	-89.9	Load combination-1
Shear - Vz	-42.0	0.0	29.3	0.0	0.0	-94.8	Load combination-6

B15 - B end	N [kN]	Mx [kNm]	My [kNm]	Mz [kNm]	Vy [kN]	Vz [kN]	Load combinations
Axial force	-35.4	-0.1	30.8	-0.1	0.0	76.3	Load combination-11
Compression	-35.4	-0.1	30.8	-0.1	0.0	76.3	Load combination-11
Torsion - Mx	-35.4	-0.1	30.8	-0.1	0.0	76.3	Load combination-11
Bending - My	-35.4	-0.1	30.8	-0.1	0.0	76.3	Load combination-11
Bending - Mz	-26.8	0.0	23.1	-0.3	0.2	89.1	Load combination-1

Fig. 7 - Summary of salient output results

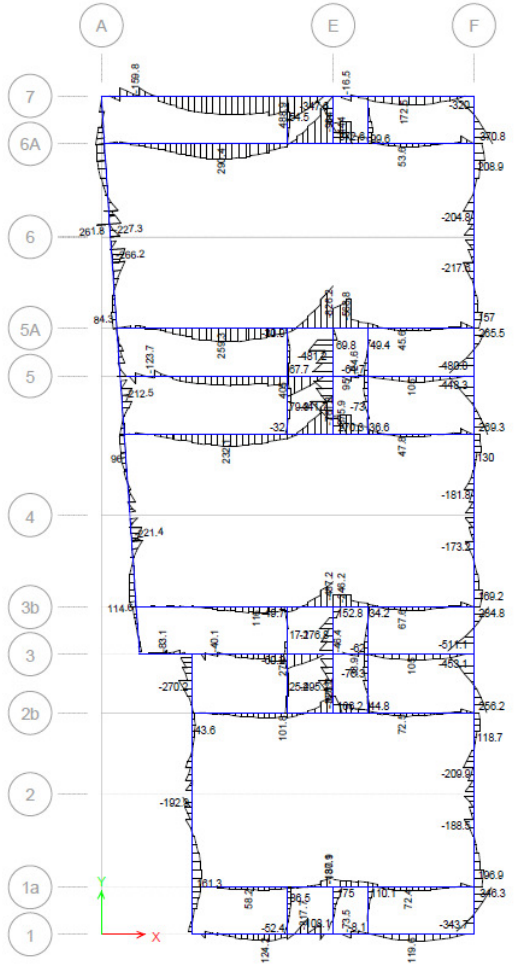


Fig. 8 - Summary of salient output results (pictorial)

Examples of Summary of Design in Design Calculation

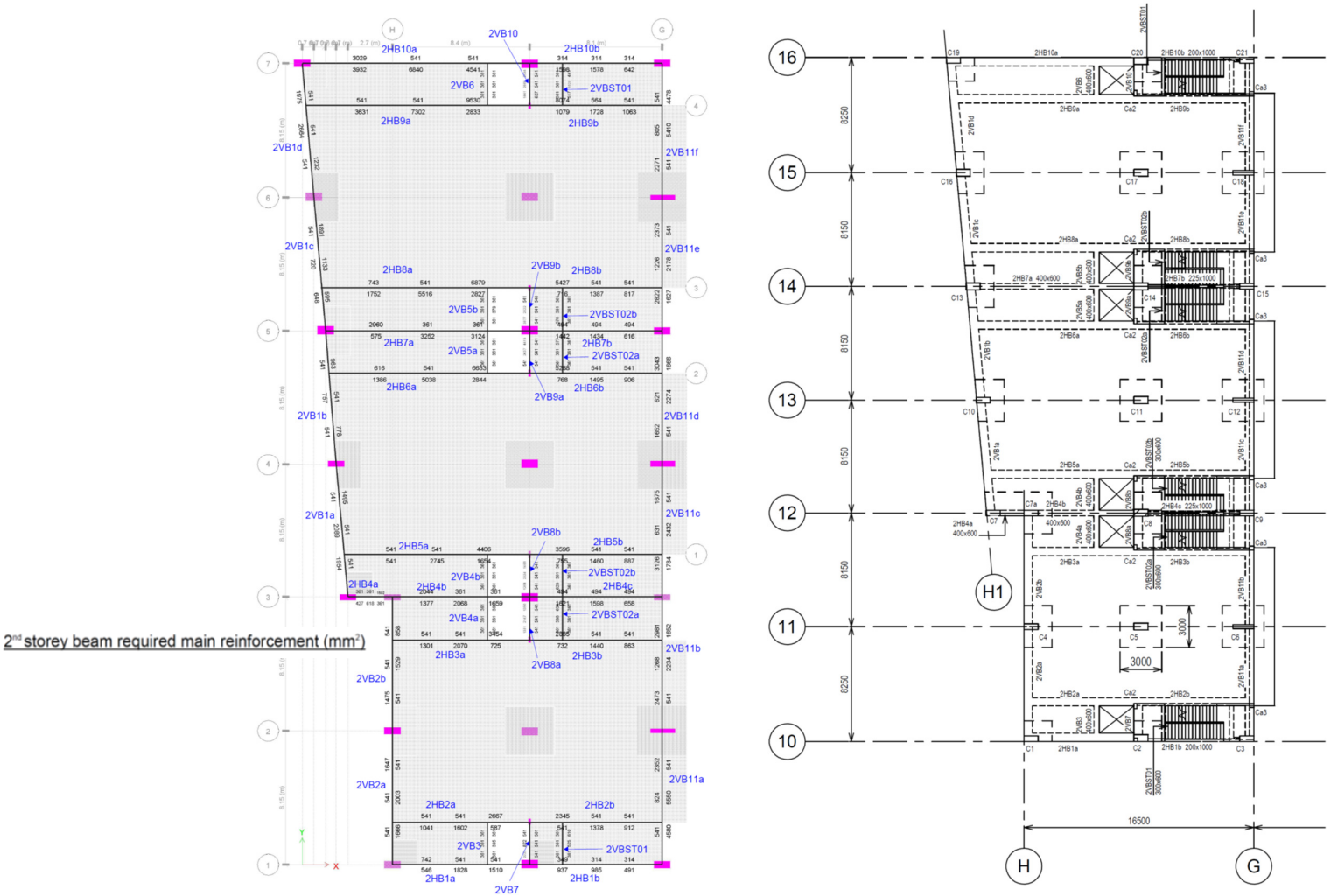


Fig. 9 - Summary of beam design with the beam labels in one plan (same as structural plan)

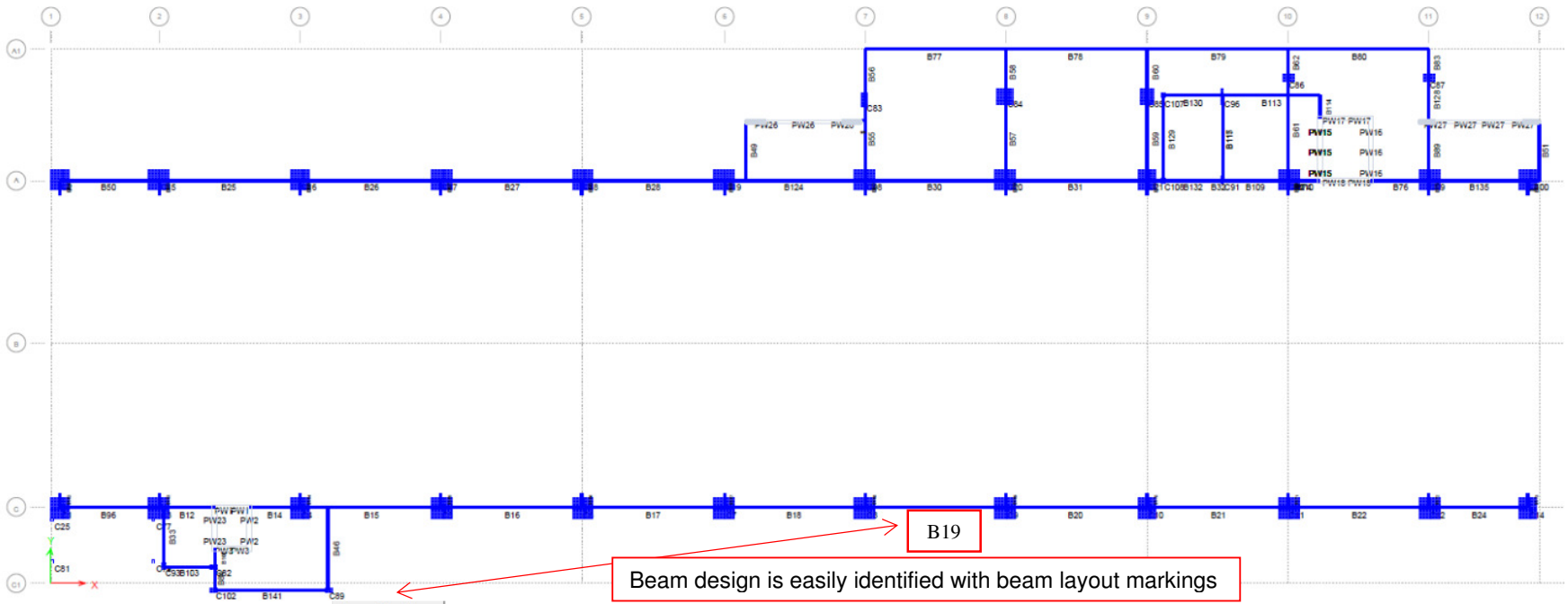
Table 1.1 - Beam Forces (Part 1 of 2, continued)

Story	Beam	Unique Name	Load Case/Combo	Station m	P kN	V2 kN	V3 kN	T kN-m	M2 kN-m	M3 kN-m
Mezzanine	B6	63	ULS+NotX	4.85	-52.8192	5.3341	0.045	-0.0012	-0.0342	367.2949
Mezzanine	B6	63	ULS+NotX	5.29	-52.8192	6.0804	0.0413	-0.0012	-0.0532	364.7837
Mezzanine	B6	63	ULS+NotX	5.29	-60.7322	152.3965	0.1872	-0.0012	-0.1766	364.7637
Mezzanine	B6	63	ULS+NotX	5.79	-60.7322	153.2446	0.1829	-0.0012	-0.2692	288.3534
Mezzanine	B6	63	ULS+NotX	6.29	-60.7322	154.0926	0.1787	-0.0012	-0.3596	211.5191
Mezzanine	B6	63	ULS+NotX	6.79	-60.7322	154.9407	0.1745	-0.0012	-0.4479	134.2608
Mezzanine	B6	63	ULS+NotX	7.29	-60.7322	155.7888	0.1702	-0.0012	-0.534	56.5784
Mezzanine	B6	63	ULS+NotX	7.29	-66.9484	240.4035	-11.4238	-0.0012	-2.6848	56.5417
Mezzanine	B6	63	ULS+NotX	7.525	-66.9484	240.8021	-11.4258	-0.0012	0	0
Mezzanine	B6	63	ULS+NotY	0.4	-42.9925	-168.5327	0.1122	-0.0006	0	0
Mezzanine	B6	63	ULS+NotY	0.85	-42.9964	-167.7695	0.1122	-0.0006	-0.0505	75.668
Mezzanine	B6	63	ULS+NotY	1.3	-43.0002	-167.0062	0.1122	-0.0006	-0.101	150.9925
Mezzanine	B6	63	ULS+NotY	1.75	-43.004	-166.243	0.1122	-0.0006	-0.1515	225.9736
Mezzanine	B6	63	ULS+NotY	2.2	-43.0078	-165.4797	0.1122	-0.0006	-0.202	300.6112
Mezzanine	B6	63	ULS+NotY	2.65	-43.0116	-164.7165	0.1122	-0.0006	-0.2525	374.9053
Mezzanine	B6	63	ULS+NotY	2.65	-52.4224	1.6026	0.0395	-0.0006	0.1205	374.9253
Mezzanine	B6	63	ULS+NotY	3.09	-52.4261	2.3489	0.0395	-0.0006	0.1031	374.056
Mezzanine	B6	63	ULS+NotY	3.53	-52.4299	3.0952	0.0395	-0.0006	0.0857	372.8583
Mezzanine	B6	63	ULS+NotY	3.97	-52.4336	3.8415	0.0395	-0.0006	0.0683	371.3322
Mezzanine	B6	63	ULS+NotY	4.41	-52.4373	4.5878	0.0395	-0.0006	0.0509	369.4778
Mezzanine	B6	63	ULS+NotY	4.85	-52.441	5.3341	0.0395	-0.0006	0.0335	367.2949
Mezzanine	B6	63	ULS+NotY	5.29	-52.4448	6.0804	0.0395	-0.0006	0.0161	364.7838
Mezzanine	B6	63	ULS+NotY	5.29	-60.7358	152.3965	0.2052	-0.0006	-0.2961	364.7637
Mezzanine	B6	63	ULS+NotY	5.79	-60.74	153.2446	0.2052	-0.0006	-0.3987	288.3534
Mezzanine	B6	63	ULS+NotY	6.29	-60.7442	154.0926	0.2052	-0.0006	-0.5013	211.5191
Mezzanine	B6	63	ULS+NotY	6.79	-60.7485	154.9407	0.2052	-0.0006	-0.6039	134.2608
Mezzanine	B6	63	ULS+NotY	7.29	-60.7527	155.7888	0.2052	-0.0006	-0.7066	56.5784
Mezzanine	B6	63	ULS+NotY	7.29	-67.7667	240.4035	-15.3248	-0.0006	-3.6013	56.5416
Mezzanine	B6	63	ULS+NotY	7.525	-67.7687	240.8021	-15.3248	-0.0006	0	0
Mezzanine	B7	65	ULS	0.4	-16.2342	-470.6809	0.203	-0.0003	0	0
Mezzanine	B7	65	ULS	0.7	-16.2342	-470.172	0.203	-0.0003	-0.0609	141.1279
Mezzanine	B7	65	ULS	0.7	-15.2189	-295.0956	-0.0021	-0.0003	0.0189	141.1012
Mezzanine	B7	65	ULS	1.106	-15.2189	-294.407	-0.0021	-0.0003	0.0198	260.7702
Mezzanine	B7	65	ULS	1.512	-15.2189	-293.7183	-0.0021	-0.0003	0.0206	380.1597
Mezzanine	B7	65	ULS	1.918	-15.2189	-293.0297	-0.0021	-0.0003	0.0215	499.2695
Mezzanine	B7	65	ULS	2.324	-15.2189	-292.3411	-0.0021	-0.0003	0.0223	618.0998
Mezzanine	B7	65	ULS	2.73	-15.2189	-291.6525	-0.0021	-0.0003	0.0232	736.6505
Mezzanine	B7	65	ULS	2.73	-14.5759	4.0571	0.0135	-0.0003	0.0209	736.6368
Mezzanine	B7	65	ULS	3.1733	-14.5759	4.8091	0.0135	-0.0003	0.0149	734.6715
Mezzanine	B7	65	ULS	3.6167	-14.5759	5.561	0.0135	-0.0003	0.009	732.3727
Mezzanine	B7	65	ULS	4.06	-14.5759	6.313	0.0135	-0.0003	0.003	729.7407
Mezzanine	B7	65	ULS	4.5033	-14.5759	7.0649	0.0135	-0.0003	-0.003	726.7752
Mezzanine	B7	65	ULS	4.9467	-14.5759	7.8169	0.0135	-0.0003	-0.009	723.4764
Mezzanine	B7	65	ULS	5.39	-14.5759	8.5688	0.0135	-0.0003	-0.0149	719.8443
Mezzanine	B7	65	ULS	5.39	-13.8431	335.3599	0.0067	-0.0003	0.0144	719.8591
Mezzanine	B7	65	ULS	5.817	-13.8431	336.0842	0.0067	-0.0003	0.0115	576.5058
Mezzanine	B7	65	ULS	6.244	-13.8431	336.8084	0.0067	-0.0003	0.0086	432.8432
Mezzanine	B7	65	ULS	6.671	-13.8431	337.5327	0.0067	-0.0003	0.0058	288.8714
Mezzanine	B7	65	ULS	7.098	-13.8431	338.2569	0.0067	-0.0003	0.0029	144.5903

Table 1.1 - Beam Forces (Part 1 of 2, continued)

Story	Beam	Unique Name	Load Case/Combo	Station m	P kN	V2 kN	V3 kN	T kN-m	M2 kN-m	M3 kN-m
Mezzanine	B7	65	ULS	7.525	-13.8431	338.9812	0.0067	-0.0003	0	0
Mezzanine	B7	65	ULS+NotX	0.4	-16.2794	-470.6809	0.0171	0.0008	0	0
Mezzanine	B7	65	ULS+NotX	0.7	-16.2794	-470.1721	0.0145	0.0008	-0.0047	141.1279
Mezzanine	B7	65	ULS+NotX	0.7	-15.2746	-295.0956	-0.0048	0.0008	0.0264	141.101
Mezzanine	B7	65	ULS+NotX	1.106	-15.2746	-294.407	-0.0083	0.0008	0.029	260.77
Mezzanine	B7	65	ULS+NotX	1.512	-15.2746	-293.7184	-0.0117	0.0008	0.0331	380.1595
Mezzanine	B7	65	ULS+NotX	1.918	-15.2746	-293.0297	-0.0152	0.0008	0.0385	499.2693
Mezzanine	B7	65	ULS+NotX	2.324	-15.2746	-292.3411	-0.0186	0.0008	0.0454	618.0996
Mezzanine	B7	65	ULS+NotX	2.73	-15.2746	-291.6525	-0.0221	0.0008	0.0537	736.6503
Mezzanine	B7	65	ULS+NotX	2.73	-14.8603	4.0571	0.0201	0.0008	0.0093	736.6365
Mezzanine	B7	65	ULS+NotX	3.1733	-14.8603	4.8091	0.0164	0.0008	0.0012	734.6712
Mezzanine	B7	65	ULS+NotX	3.6167	-14.8603	5.561	0.0126	0.0008	-0.0052	732.3725
Mezzanine	B7	65	ULS+NotX	4.06	-14.8603	6.313	0.0088	0.0008	-0.01	729.7404
Mezzanine	B7	65	ULS+NotX	4.5033	-14.8603	7.0649	0.0051	0.0008	-0.0131	726.775
Mezzanine	B7	65	ULS+NotX	4.9467	-14.8603	7.8169	0.0013	0.0008	-0.0145	723.4762
Mezzanine	B7	65	ULS+NotX	5.39	-14.8603	8.5688	-0.0024	0.0008	-0.0143	719.8441
Mezzanine	B7	65	ULS+NotX	5.39	-14.4991	335.3599	0.0174	0.0008	0.0177	719.8591
Mezzanine	B7	65	ULS+NotX	5.817	-14.4991	336.0842	0.0137	0.0008	0.0111	576.5058
Mezzanine	B7	65	ULS+NotX	6.244	-14.4991	336.8084	0.0101	0.0008	0.006	432.8432
Mezzanine	B7	65	ULS+NotX	6.671	-14.4991	337.5327	0.0065	0.0008	0.0025	288.8714
Mezzanine	B7	65	ULS+NotX	7.098	-14.4991	338.2569	0.0029	0.0008	0.0005	144.5903
Mezzanine	B7	65	ULS+NotX	7.525	-14.4991	338.9811	-0.0007	0.0008	0	0
Mezzanine	B7	65	ULS+NotY	0.4	-15.9479	-470.6809	-0.1561	-0.0007	0	0
Mezzanine	B7	65	ULS+NotY	0.7	-15.9505	-470.172	-0.1561	-0.0007	0.0468	141.1279
Mezzanine	B7	65	ULS+NotY	0.7	-14.2884	-295.0956	-0.0111	-0.0007	0.0064	141.1012
Mezzanine	B7	65	ULS+NotY	1.106	-14.2919	-294.407	-0.0111	-0.0007	0.0109	260.7702
Mezzanine	B7	65	ULS+NotY	1.512	-14.2953	-293.7183	-0.0111	-0.0007	0.0153	380.1597
Mezzanine	B7	65	ULS+NotY	1.918	-14.2987	-293.0297	-0.0111	-0.0007	0.0198	499.2695
Mezzanine	B7	65	ULS+NotY	2.324	-14.3022	-292.3411	-0.0111	-0.0007	0.0243	618.0998
Mezzanine	B7	65	ULS+NotY	2.73	-14.3056	-291.6525	-0.0111	-0.0007	0.0288	736.6505
Mezzanine	B7	65	ULS+NotY	2.73	-13.3194	4.0571	0.0041	-0.0007	0.0071	736.6368
Mezzanine	B7	65	ULS+NotY	3.1733	-13.3232	4.8091	0.0041	-0.0007	0.0053	734.6715
Mezzanine	B7	65	ULS+NotY	3.6167	-13.3269	5.561	0.0041	-0.0007	0.0035	732.3728
Mezzanine	B7	65	ULS+NotY	4.06	-13.3307	6.313	0.0041	-0.0007	0.0016	729.7407
Mezzanine	B7	65	ULS+NotY	4.5033	-13.3344	7.0649	0.0041	-0.0007	-0.0002	726.7752
Mezzanine	B7	65	ULS+NotY	4.9467	-13.3382	7.8169	0.0041	-0.0007	-0.002	723.4764
Mezzanine	B7	65	ULS+NotY	5.39	-13.342	8.5688	0.0041	-0.0007	-0.0039	719.8443
Mezzanine	B7	65	ULS+NotY	5.39	-12.6846	335.3599	-0.0034	-0.0007	-0.0072	719.8591
Mezzanine	B7	65	ULS+NotY	5.817	-12.6882	336.0842	-0.0034	-0.0007	-0.0058	576.5058
Mezzanine	B7	65	ULS+NotY	6.244	-12.6918	336.8084	-0.0034	-0.0007	-0.0043	432.8432
Mezzanine	B7	65	ULS+NotY	6.671	-12.6955	337.5327	-0.0034	-0.0007	-0.0029	288.8714
Mezzanine	B7	65	ULS+NotY	7.098	-12.6991	338.2569	-0.0034	-0.0007	-0.0014	144.5903
Mezzanine	B7	65	ULS+NotY	7.525	-12.7027	338.9812	-0.0034	-0.0007	0	0
Mezzanine	B11	66	ULS	0.4	5.7847	-334.3464	-0.0006	-0.0027	0	0
Mezzanine	B11	66	ULS	0.85	5.7847	-333.5832	-0.0006	-0.0027	0.0003	150.2842
Mezzanine	B11	66	ULS	1.3	5.7847	-332.8199	-0.0006	-0.0027	0.0005	300.2248
Mezzanine	B11	66	ULS	1.75	5.7847	-332.0566	-0.0006	-0.0027	0.0008	449.8221
Mezzanine	B11	66	ULS	2.2	5.7847	-331.2934	-0.0006	-0.0027	0.0011	599.0758
Mezzanine	B11	66	ULS	2.65	5.7847	-330.5301	-0.0006	-0.0027	0.0013	747.9861

Fig. 10 - Summary of beam design with beam labels



Beam Checking

ANNEX 2--STOREY BEAM CHECKING

Frame	Section	Location	Comb	TopArea	BotArea	Shear	TopArea((mm)		BotArea(mm)		Shear(mm/m)		Result
B19	B300X800	650	C107F	763	354	272	3H20	942	3H20	942	H10-300	524	OKI
B19	B300X800	4500	C109	354	413	272	3H20	942	3H20	942	H10-300	524	OKI
B19	B300X800	8350	C107	773	354	272	3H20	942	3H20	942	H10-300	524	OKI

1A2HB25 (300X800)

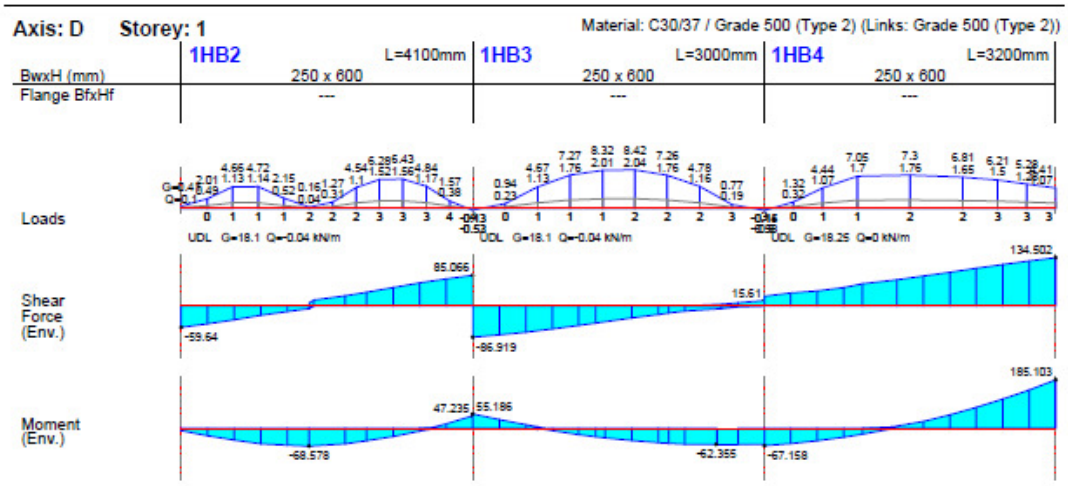
							AC				PE		
Frame	Section	Location	Comb	TopArea	BotArea	Shear	TopArea((mm)		BotArea(mm)		Shear(mm/m)		Result
B20	B300X800	650	C107F	763	354	272	3H20	942	3H20	942	H10-300	524	OKI
B20	B300X800	4500	C109	354	414	272	3H20	942	3H20	942	H10-300	524	OKI
B20	B300X800	8350	C107	774	354	272	3H20	942	3H20	942	H10-300	524	OKI

1A2HB26 (300X800)

							AC				PE		
Frame	Section	Location	Comb	TopArea	BotArea	Shear	TopArea((mm)		BotArea(mm)		Shear(mm/m)		Result
B21	B300X800	650	C107F	757	354	272	3H20	942	3H20	942	H10-300	524	OKI
B21	B300X800	4500	C109	354	414	272	3H20	942	3H20	942	H10-300	524	OKI
B21	B300X800	8350	C107	782	354	272	3H20	942	3H20	942	H10-300	524	OKI

1A2HB27 (300X800)

Fig. 11 - Beam design and beam layout plan shown in design calculations



Bending (Top Edge)									
M (kN.m)	17.14		47.24	55.19		14.95	8.88	70.99	185.10
d (mm)	549		549	549		547	547	545	545
K/K'	0.04		0.10	0.12		0.03	0.02	0.15	0.40
x (mm)	68.56		68.56	68.56		68.38	68.38	68.13	108.54
Asm (mm2)	76		208	244		66	39	315	849
Asv (mm2)	171		245	250		54	164	291	387
As (mm2)	76		208	244		66	203	606	849
As' (mm2)	0		0	0		0	0	0	0
As-min	207	207	207	207	207	206	206	205	205
Bending (Bottom Edge)									
M (kN.m)	44.34	68.58	9.66	0.37	59.81	62.35	67.16	35.52	
d (mm)	549	549	549	549	549	549	549	549	
K/K'	0.10	0.15	0.02	0.00	0.13	0.13	0.14	0.08	
x (mm)	68.56	68.56	68.56	68.56	68.56	68.56	68.56	68.56	
Asm (mm2)	196	303	43	2	264	275	296	157	
Asv (mm2)	171	149	245	250	183	54	164	291	
As (mm2)	303	303	287	252	275	275	296	296	
As' (mm2)	0	0	0	0	0	0	0	0	
As-min	207	207	207	207	207	207	207	207	207
Shear and Torsion Design ...									
Vd (kN)	59.64		85.07	86.92		18.76	57.02		134.50
v (N/mm2)	0.43		0.62	0.63		0.14	0.42		0.99
v-Rdc (N/mm2)	0.40	0.00	0.39	0.39	0.00	0.40	0.40	0.00	0.53
v-Rdmax (N/mm2)	4.75		4.75	4.75		4.75	4.75		4.75
V-Rd (kN)	280.97		280.97	280.97		280.97	280.97		280.97
Vnom (kN)		280.95			280.95			280.95	
Td (kN.m)		0.37			0.08			0.27	
T-min (kN.m)		6.62			6.62			6.62	
b-sup (mm)	0		0	0		0	0		0
Links	**H10-300**	**H10-300**	**H10-300**	**H10-300**	**H10-300**	**H10-300**	**H10-300**	**H10-300**	**H10-300**
Deflection Check ...									
L/d	7.47 < 107.71 OK			5.47 < 158.99 OK			5.83 < 131.19 OK		
Provided Steel Areas (mm2)									
Top Edge	265	265	265	265	265	603	603	942	942
Bottom Edge	398	398	398	398	398	398	398	398	398
Steel Bars ...									
Top Bar		2H13			2H13			3H20	
Top SupBar			2H13	2H13		3H16	3H16		3H20
Top SupBar									
Bottom Bar		3H13			3H13			3H13	
Bottom Bar									
Bot SupBar									
Side Bars									

Fig. 12 - Beam analysis and design with beam markings (same as structural plan) shown in design calculation

Recommended Design Workflow using BIM

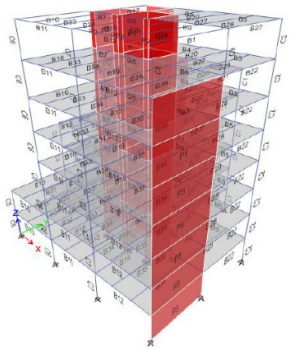
Import A&D model with properties
(e.g. element ID, geometry, dimensions, material properties, support conditions)

A&D MODEL*

DATA EXCHANGE between models through available plug-ins

BIM MODEL

Update A&D model properties
(e.g. geometry, dimensions, material properties) from BIM model



*A&D model refers to 3-D model in the analysis & design software