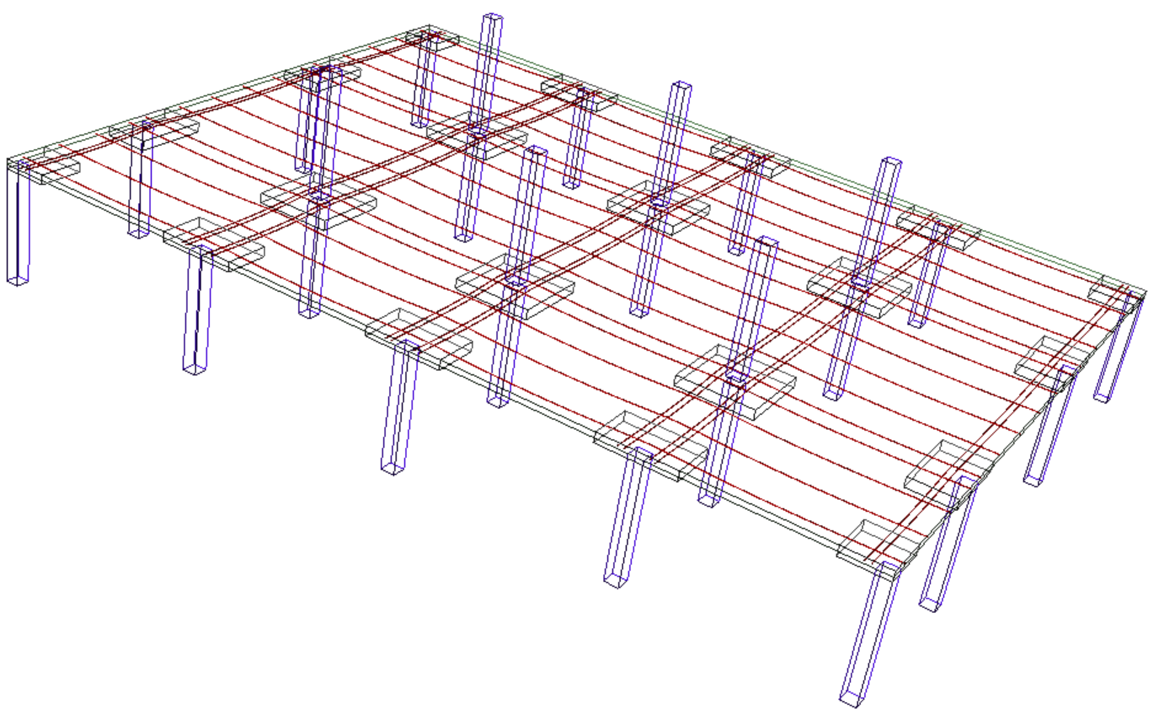
ADAPT
STRUCTURAL ENGINEERING CONSULTANTS

TN342_design_example_2-way_mondana_093009

STRUCTURAL CALCULATIONS

For

Post-Tensioned
FLAT SLAB WITH DROP CAPS



Mondana Building
Floor system

ROYA CONSTRUCTION
Building Division

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OVERVIEW AND SCOPE

This report presents the structural engineering calculations of a post-tensioned flat slab supported on columns, using Hong Kong building code HKCOP 2004 and its amendment of June 2007. The general criteria used for the design, such as details of material properties are given in a separate report entitled "Structural Design Criteria." Features of the geometry and details of loads applicable to the floor slab covered by this report are included herein.

The requirements called for a "Class 3" design. This means that the computed tensile stresses at the extreme fibers would exceed 0.36√ fcu. For the specified concrete material of 40 MPa cube strength, this translates to tensile stresses exceeding 5.5 MPa. To meet the design requirements, a low value for post-tensioning had to be specified, in order to induce cracking in the slab. At the same time, the post-tensioning selected was not to be less than the value necessary for lightly reinforced slabs to meet temperature and shrinkage requirements, and also act satisfactorily as a diaphragm in distributing the wind and seismic forces among the lateral force resisting members of the building. An average precompression of 0.7[1] MPa is used for these requirements.

The design moment of the slab is modified for each design section to include the twisting moment of the same section (Wood-Armer) approximation. As a result, the design moments used for the determination of reinforcement are somewhat larger than the actual bending moments generated in the slab

The design uses the program ADAPT Floor Pro release 2009/2010 featuring the Hong Kong Code.

A review of the design values suggests that a more balanced design option for the subject matter floor slab would be to increase the amount of post-tensioning provided. This will reduce the number of non-prestressed bars reported by the program and improve the constructability of the project. However, the post-tensioning was kept at a low value to achieve a Class 3 design alternative.

LIST OF CONTENTS

[1] Aalami, B. O., and Jurgens, J. D. (2003), "*Guidelines for the Design of Post-Tensioned Floors*," American Concrete Institute, Concrete International Journal, March 2003, pp. 77-83. (2003)

- S23 support line identification in y- direction
- S24 design strip display in x-direction
- S25 design strip display in y-direction
- S26 Strength moment display along xx
- S27 Strength moment display along y-y
- S28 Design section stress check along xx
- S29 Design section stress check along y-y
- S30 Design Legend
- S31 Design check for each support line (there will be as many sheets as support lines)
- S32 Reinforcement plan from computations
- S40 Column identification plans
- S41 Lower column reactions (include only the strength check load combinations)
- S42-1 Punching shear stress check plan (showing stress check results)
- S42-2 Punching shear stress check tabular results
- S43-1 Punching shear reinforcement table
- S43-2 Punching shear reinforcement layout - details
- S44 Punching shear stress check parameters

S3 - REFLECTIONOF PROGRAM PRINTOUT OF INPUT DESIGN CRITERIA

117 MATERIALS

117.20 CONCRETE MATERIAL PROPERTIES

ID	Label	f'c	Unit Weight	Type	Ec	Creep coefficient
		MPa	kg/m3		MPa	
1	C40	40.00	2447.32	Normal	21077	2.00

f'c = strength at 28 days
Ec = modulus of elasticity at 28 days

117.40 REINFORCEMENT (NONPRESTRESSED) MATERIAL PROPERTIES

ID	Label	fy	fvy	Es
		MPa	MPa	MPa
1	High YS	460.00	460.00	200000

fy = yield stress of longitudinal reinforcement
fvy = yield stress of one-way shear reinforcement
Es = modulus of elasticity

117.60 PRESTRESSING MATERIAL PROPERTIES

ID	Label	fpu	fpy	Eps
		MPa	MPa	MPa
1	BS5896	1860.00	1580.00	198000

fpu = ultimate stress
fpy = yield stress
Eps = modulus of elasticity

142 CODES AND ASSUMPTIONS

142.15 TORSIONAL STIFFNESS OF BEAMS ACCOUNTED FOR
142.16 TORSIONAL STIFFNESS OF LOWER COLUMNS ACCOUNTED FOR
142.17 TORSIONAL STIFFNESS OF UPPER COLUMNS ACCOUNTED FOR

142.20 MATERIAL AND STRENGTH REDUCTION FACTORS
Two-way Slabs
BS8110 material factors used:

For concrete	= 1.50
For nonprestressed steel	= 1.15
For prestressed steel	= 1.15

142.30 COVER TO REINFORCEMENT
Two-way Slabs
Prestressing Tendons (CGS)

At top	= 48 mm
At bottom	= 48 mm

Nonprestressing reinforcement (cover)

At top	= 25 mm
At bottom	= 25 mm

143 DESIGN CRITERIA

143.20 TWO-WAY SLABS

Service (final) stresses
Tension stress as multiple of (f'c)^1/2

At top fibers	= 0.87
At bottom fibers	= 0.87

Compression stress as multiple of f'c

At top fibers	= 0.33
At bottom fibers	= 0.33

Initial (transfer) stresses
Tension stress as multiple of (f'c)^1/2

At top fibers	= 0.36
At bottom fibers	= 0.36

Compression stress as multiple of f'c

At top fibers	= 0.50
At bottom fibers	= 0.50

146 LOAD CASES AND COMBINATIONS

146.20 LOAD CASES
Dead load
Live load
Selfweight
Prestressing
Hyperstatic
Lateral_1

146 LOAD CASES AND COMBINATIONS

146.20 LOAD CASES
Dead load
Live load
Selfweight
Prestressing
Hyperstatic
Lateral_1

146.40 LOAD COMBINATIONS
Name: STRENGTH (ULS)
Evaluation: STRENGTH
Combination detail: 1.40 x Selfweight + 1.40 x Dead load + 1.60 x Live load + 1.00 x Hyperstatic
Name: SERVICE (SLS)
Evaluation: SERVICEABILITY
Combination detail: 1.00 x Selfweight + 1.00 x Dead load + 1.00 x Live load + 1.00 x Prestressing
Name: INITIAL
Evaluation: INITIAL
Combination detail: 1.00 x Selfweight + 1.15 x Prestressing
Name: PRESTRESS
Evaluation: NO CODE CHECK
Combination detail: 1.00 x Prestressing
Name: SWGT
Evaluation: NO CODE CHECK
Combination detail: 1.00 x Selfweight
Name: Deflection_sustained
Evaluation: NO CODE CHECK
Combination detail: 1.00 x Selfweight + 1.00 x Dead load + 0.25 x Live load + 1.00 x Prestressing
Name: Deflection_live
Evaluation: NO CODE CHECK
Combination detail: 1.00 x Live load
Name: Deflection_Characteristic
Evaluation: CRACKED DEFLECTION
Combination detail: 1.00 x Selfweight + 1.00 x Dead load + 1.00 x Live load + 1.00 x Prestressing

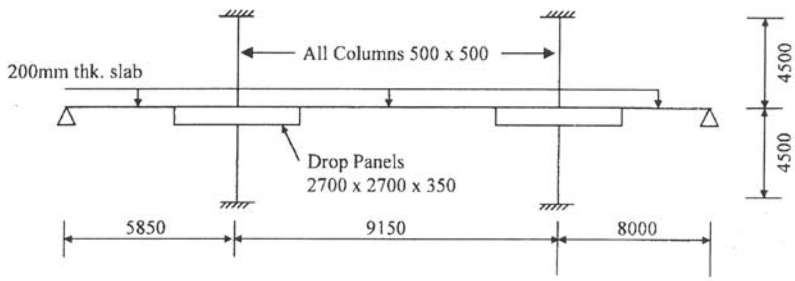
In addition to the input data reported above, the following values were also input

COVER
Bottom mesh cover = 25 mm

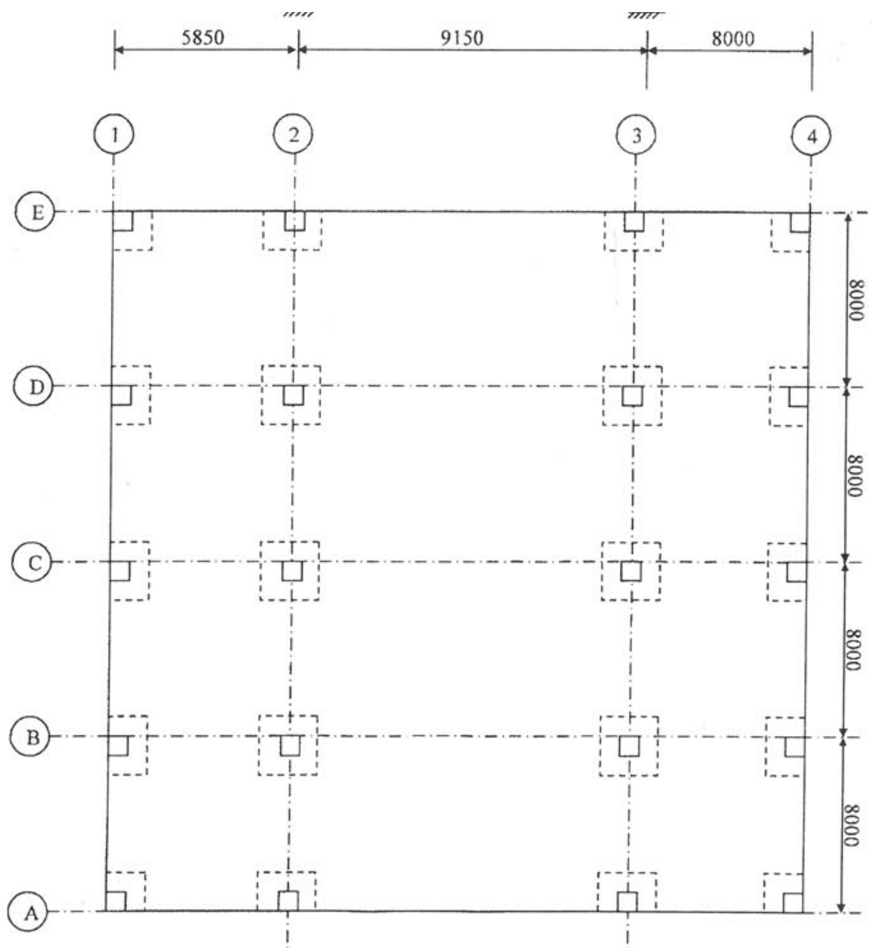
MESH AND BAR SIZE
Top and bottom longitudinal bars = 20 mm dia
Bottom mesh specified = 10mm bars @ 250 mm o.c.

S4.1 – STRUCTURE PLAN

The following figure shows the structural model of the slab used for analysis and design.



(a) Elevation



(b) Plan

FIGURE S4.1-1 GENERAL LAYOUT OF THE FLOOR SYSTEM

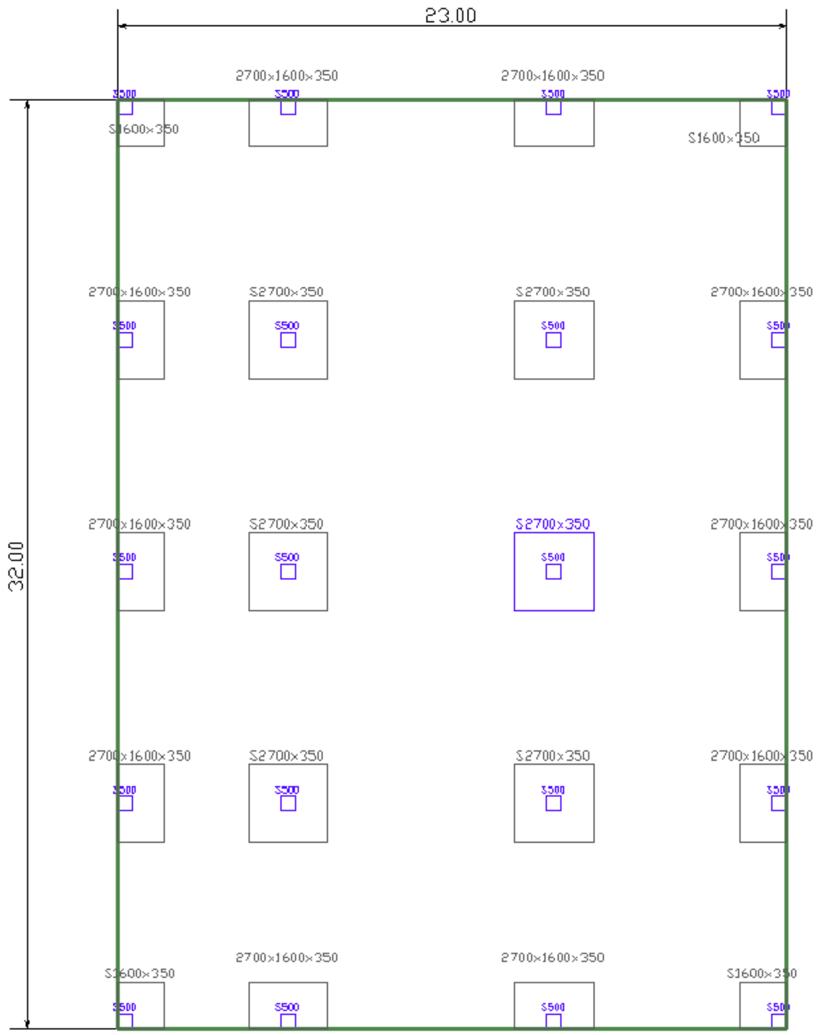


FIGURE S4.1-2 STRUCTURE PLAN SHOWING THE OUTLINE OF THE POST-TENSIONED SLAB, AND ITS GEOMETRY IN THE ANALYSIS MODEL
(S = Square; slab thickness 200 mm)

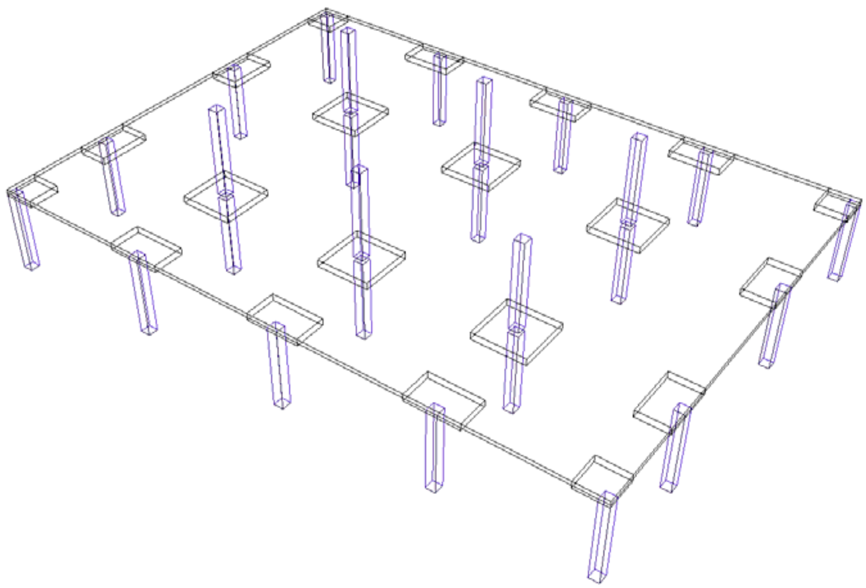


FIGURE S4-2 THREE DIMENSIONAL VIEW OF THE POST-TENSIONED SLAB AND ITS SUPPORT ARRANGEMENT

S5 – LOADING ASSUMPTIONS AND VALUES

From the design criteria, the post-tensioned slab is designed for a uniformly distributed superimposed dead load of 3.00 kN/m2 and uniformly distributed live load of 5 kN/m2. The loads generated in the design model are illustrated in following views from the analysis model.

S6 – LOAD PLANS

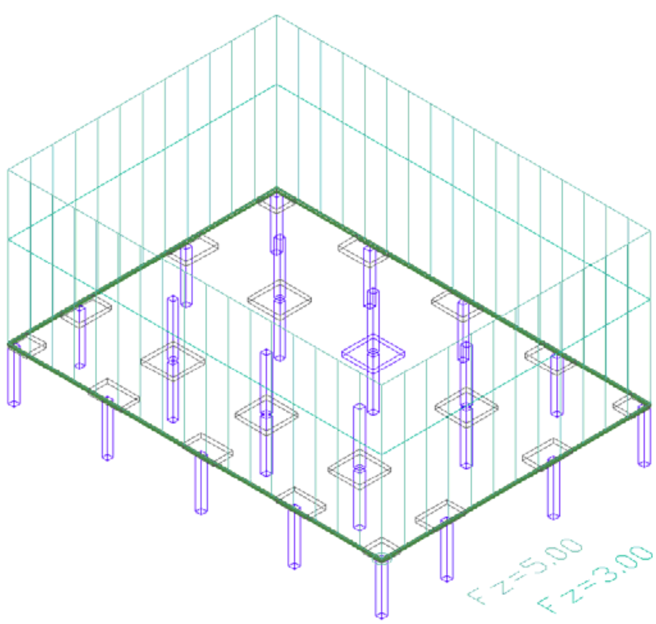


FIGURE S6-1 ASSUMED UNIFORM LOAD ON THE POST-TENSIONED SLAB (NOT INCLUDING SELFWEIGHT) SDL = 3.00 kN/m2; LL= 5.00 kN/m2

S7 - POST-TENSIONING TENDON LAYOUT

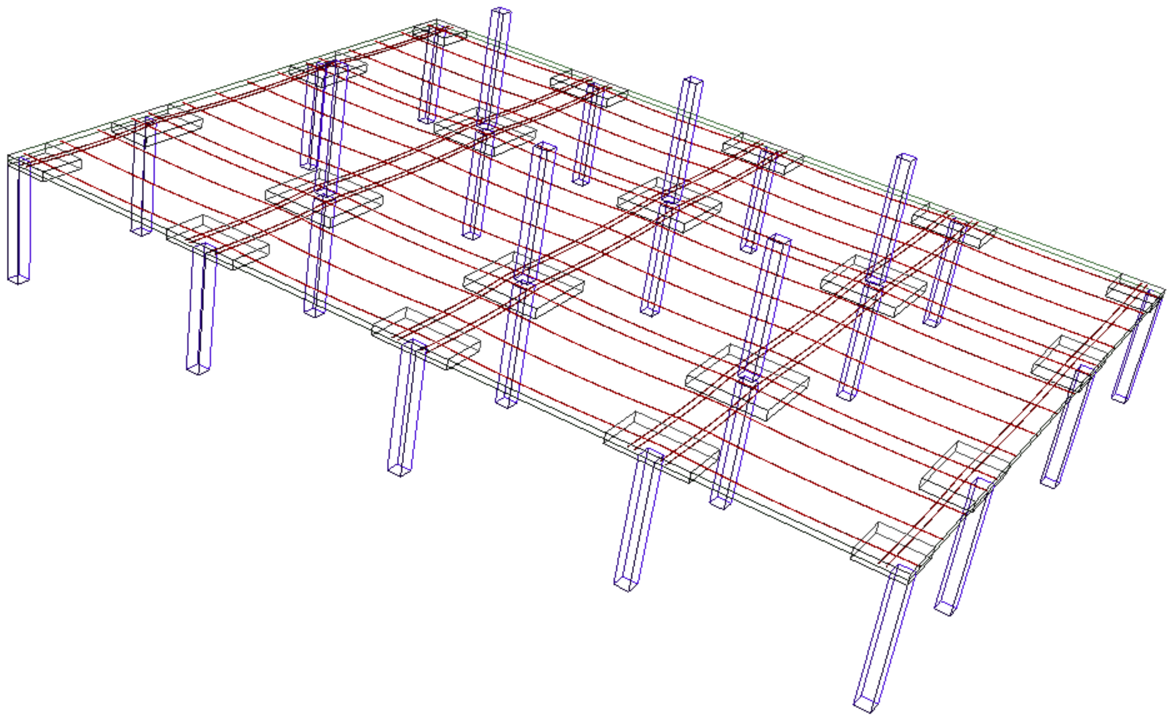


FIGURE S7-1 POST-TENSIONING TENDON LAYOUT

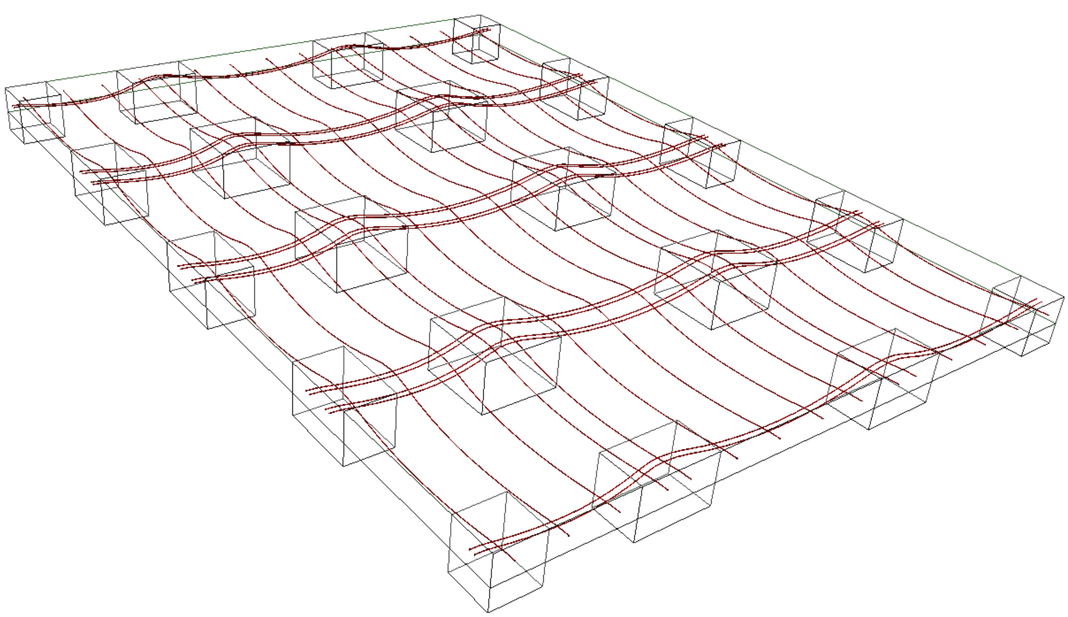


FIGURE S7-2 3D VIEW OF POST-TENSIONING TENDON LAYOUT
(exaggerated vertical scale to illustrate the features of tendon profiles)

Figure S7-3 shows the details of tendon layout. Banded tendons are shown in the left-right direction and the distributed tendons in top-down direction. The following annotation is used

S = 2 means two strands in tendon

Control point heights refer to the distance of soffit from the center of gravity of strands (CGS)

The profile of tendons in the distributed direction is generally reversed parabola. The banded tendons are modeled with a partial parabola profile.

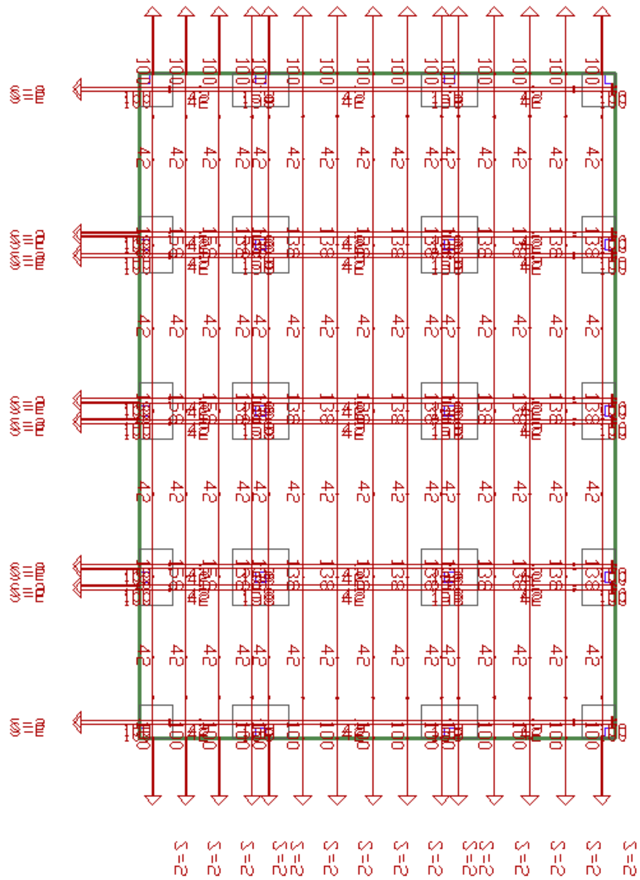


FIGURE S7-3 TENDON CONTROL HEIGHTS (CGS – center of gravity) AND NUMBER OF STRANDS

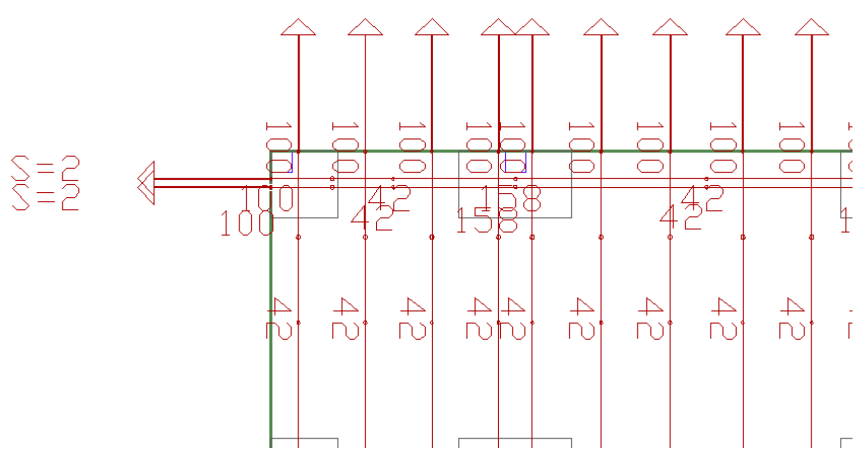


FIGURE S7-4 ENLARGED VIEW OF TENDON CGS

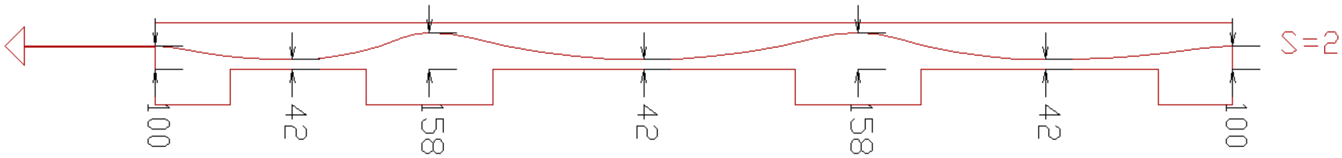


FIGURE S7-5 ELEVATION OF A TYPICAL BANDED TENDON

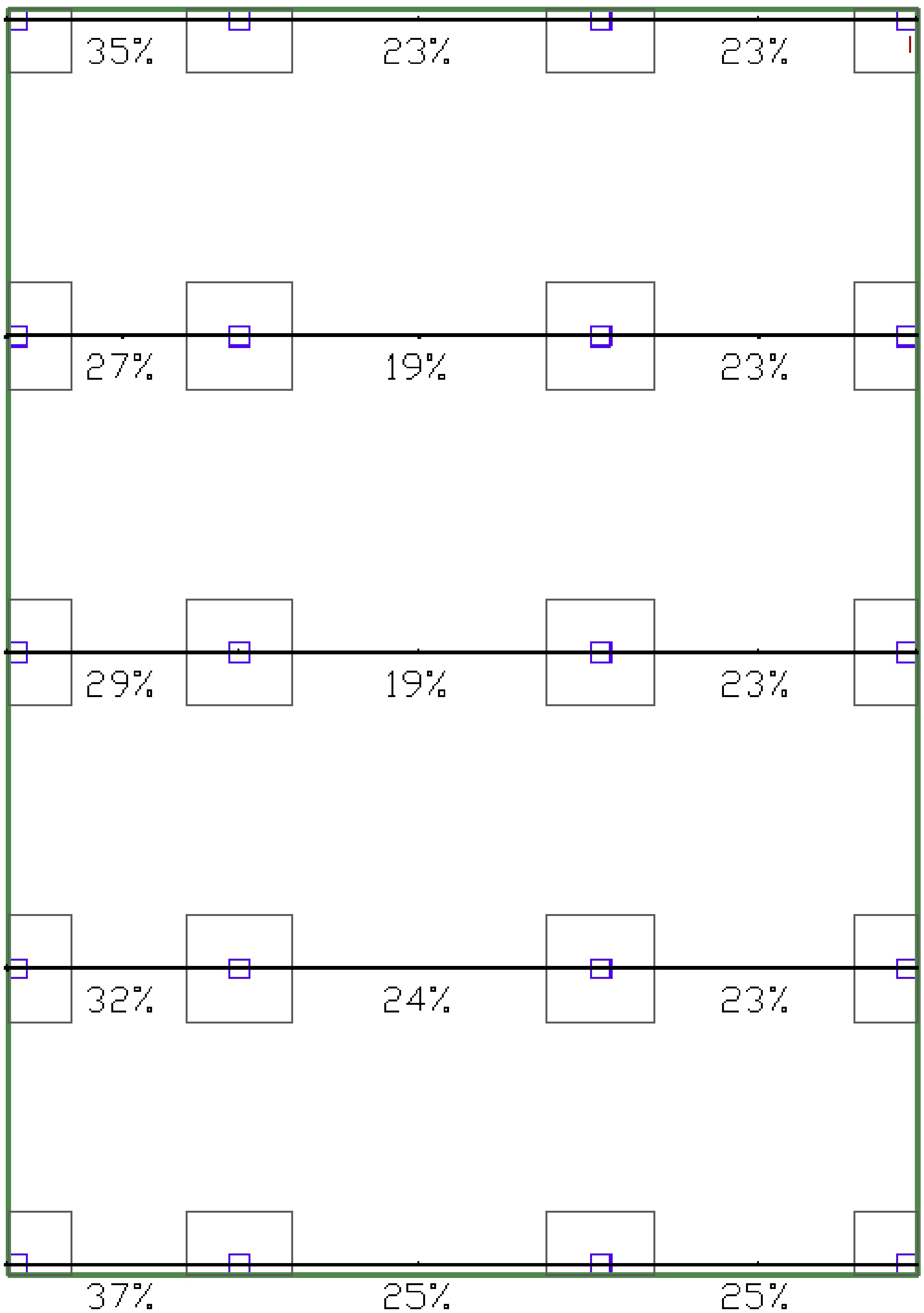


FIGURE S7-6.1 BALANCED LOADING – BANDED DIRECTION

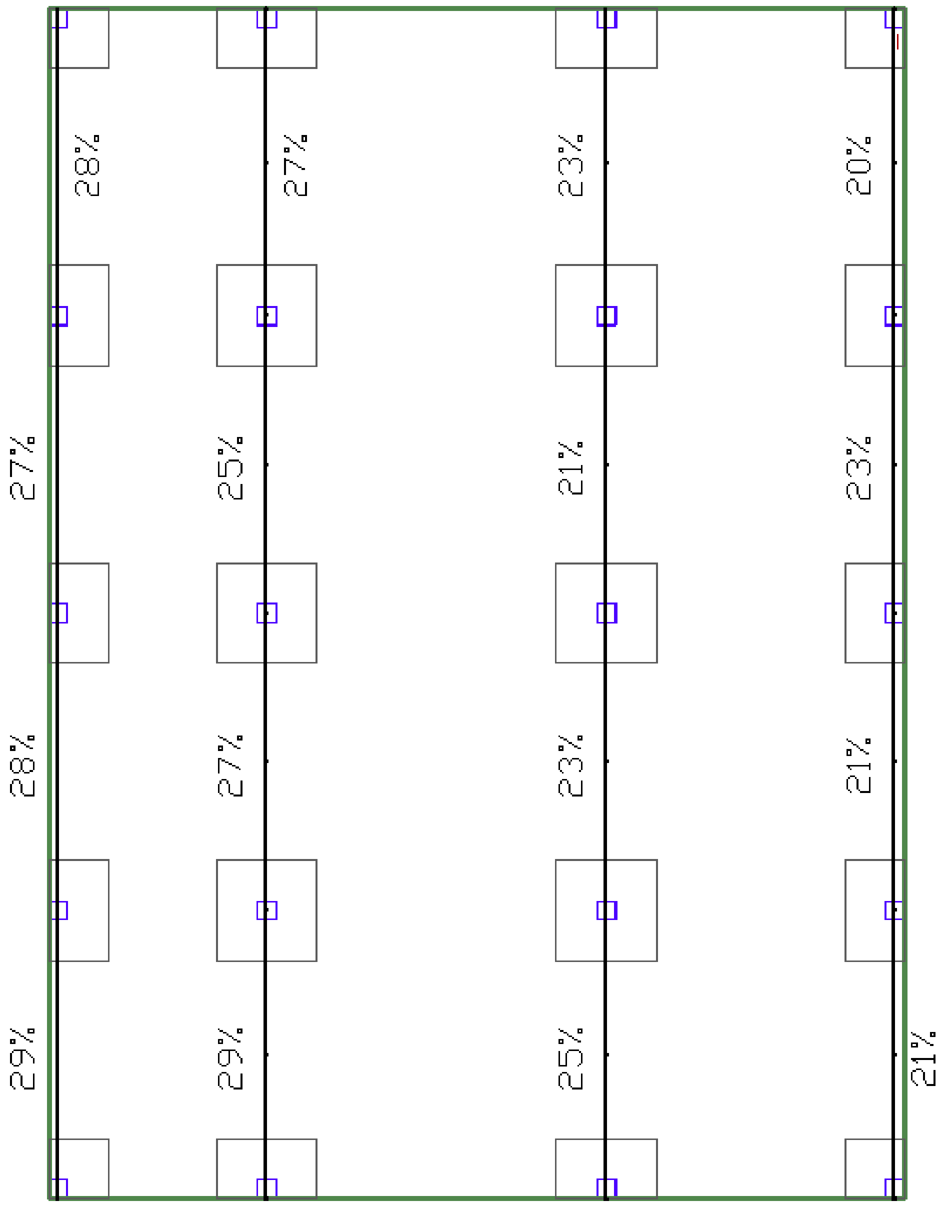


FIGURE S7-6.2 BALANCED LOADING – DISTRIBUTED DIRECTION

Comments
Review of the above two illustrations for the percentage of selfweight balanced by the prestressing tendons reveals values lesser than those commonly associated with economical designs. From the above, at critical spans about 24% of the selfweight is balanced. Noting that the selfweight for the 200 mm slab thickness selected (4.8 kN/m2) is 24% of total dead load of the structure (7.8 kN/m2), the post-tensioning in effect is balancing only 15% of the total dead load of critical spans. Consequently, as the outcome of the analysis indicated further on, essentially no cracks form in the slab under full service load (total load). For economical design of similar structures a smaller slab thickness leading to values between 60% to 80% of balanced selfweight is generally selected.[2]

[2] Aalami, B. O., and Jurgens, J. D. (2003), "*Guidelines for the Design of Post-Tensioned Floors*," American Concrete Institute, Concrete International Journal, March 2003, pp. 77-83. (2003)

ANALYSIS AND DESDIGN VALUES

S15 – FINITE ELEMENT DISCRETIZATION

The structure is discretized in well proportioned quadrilateral finite element cells for improved analysis results (Fig. S15-1).

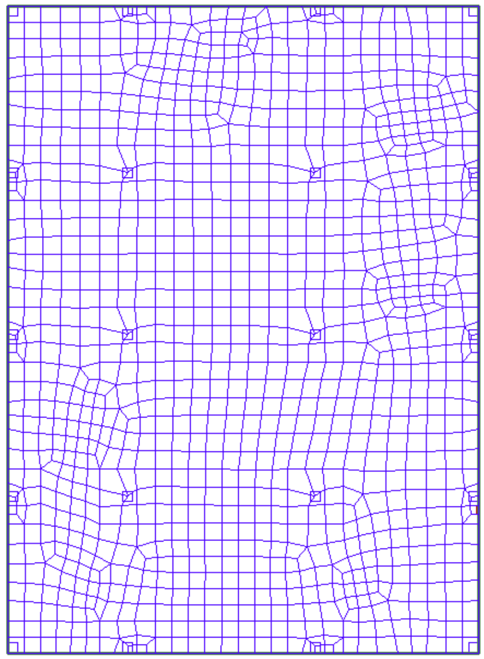


FIGURE S15-1 VIEW OF FINITE ELEMENT MESH USED FOR ANALYSIS

S20 –DEFLECTIONS – CHARACTERISTIC AND LONG-TERM

The deflection of the floor system under different scenarios are given below

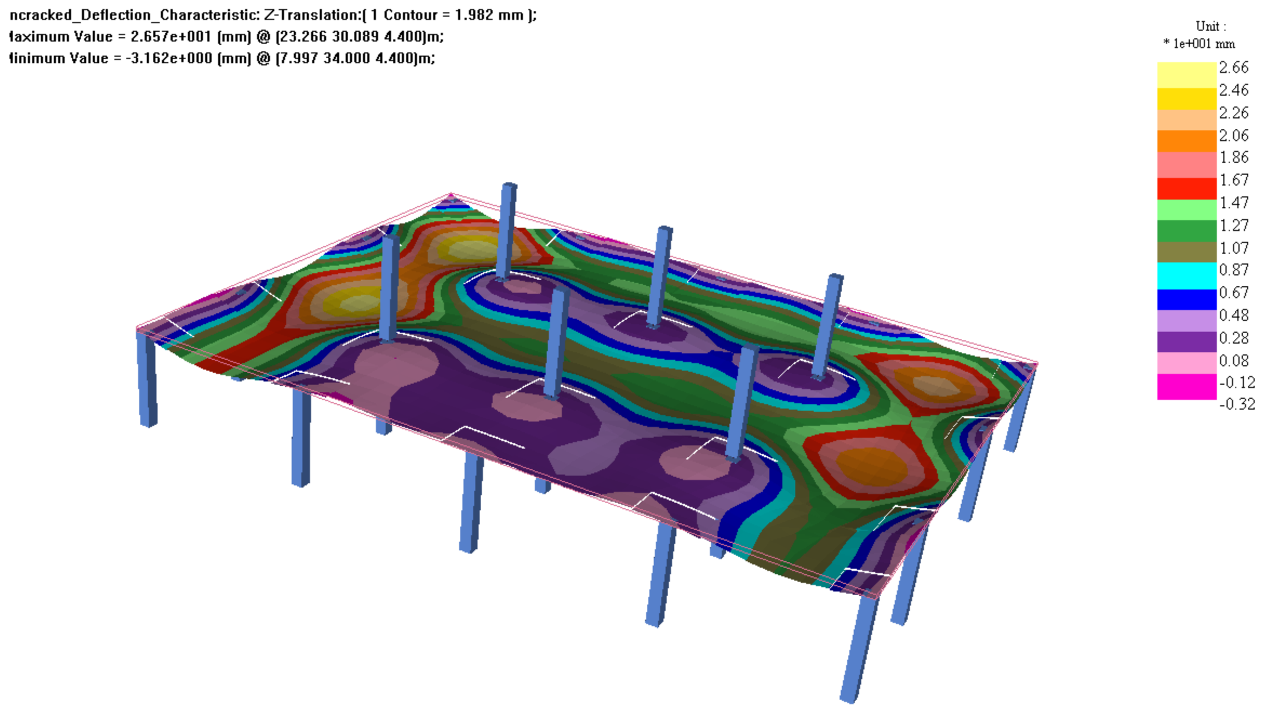


FIGURE S20-1 IMMEDIATE DEFLECTION BASED ON GROSS CROSS-SECTION (UNCRACKED) DUE TO CHARCTERISTIC LOAD COMBINATION (1.0DL + 1.0LL + 1.0PT). Maximum deflection is 26.6mm

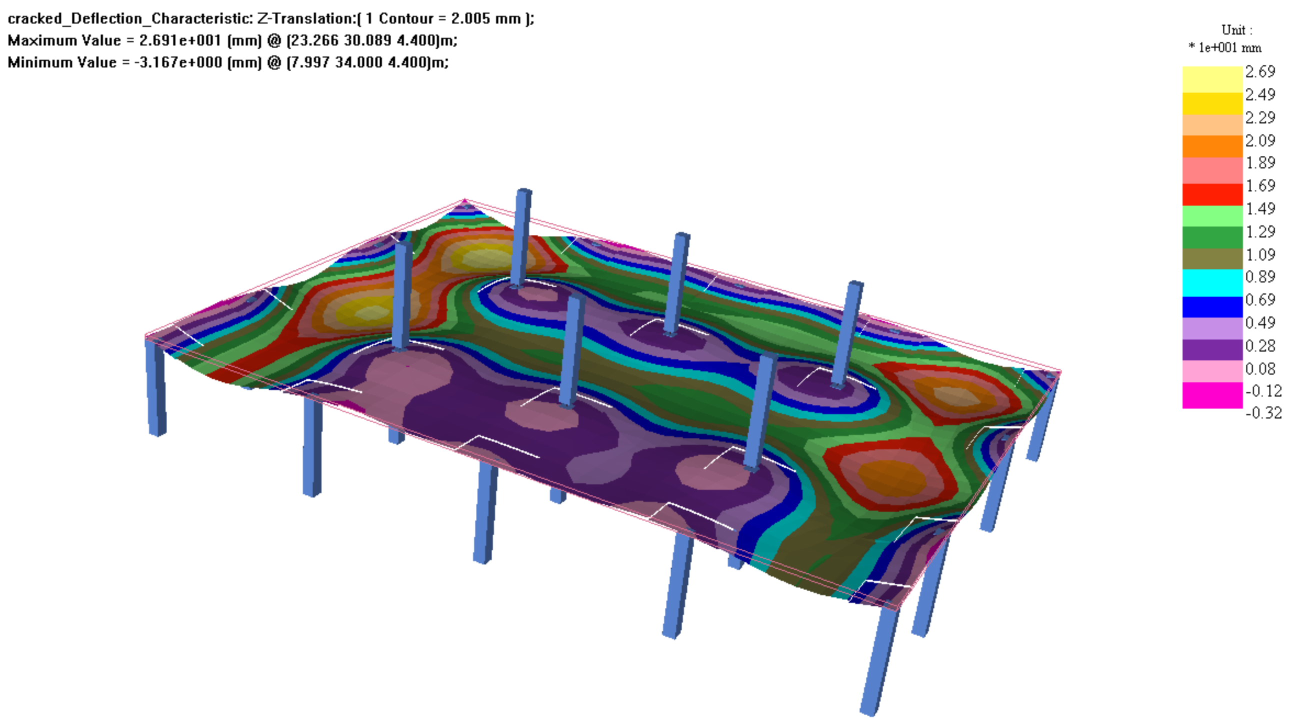


FIGURE S20-2 IMMEDIATE DEFLECTION BASED ON CRACKED -SECTION DUE TO CHARCTERISTIC LOAD COMBINATION (1.0DL + 1.0LL + 1.0PT). Maximum deflection is 26.9mm.

Note that there is only a small change in maximum deflection between the cracked and uncracked solutions, since maximum cracking has not occurred at the location of maximum deflection as is indicated in the following figure and the stress diagrams later in this report.

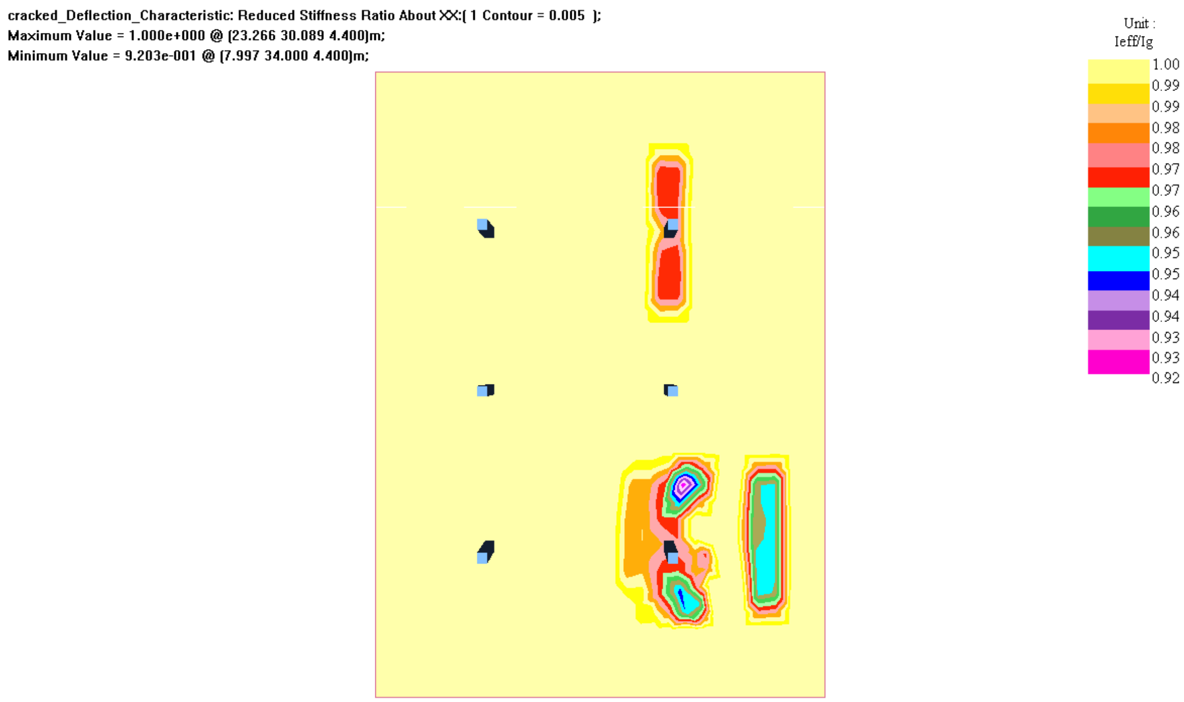


FIGURE S20-3.1 ILLUSTRATION OF LOCAL LOSS OF ROTATIONAL STIFFNESS ABOUT YY DUE TO CRACK FORAMTION UNDER CHARACTERISTIC (TOTAL) LOAD COMBINATION 1.0DL + 1.0LL + 1.0PT.

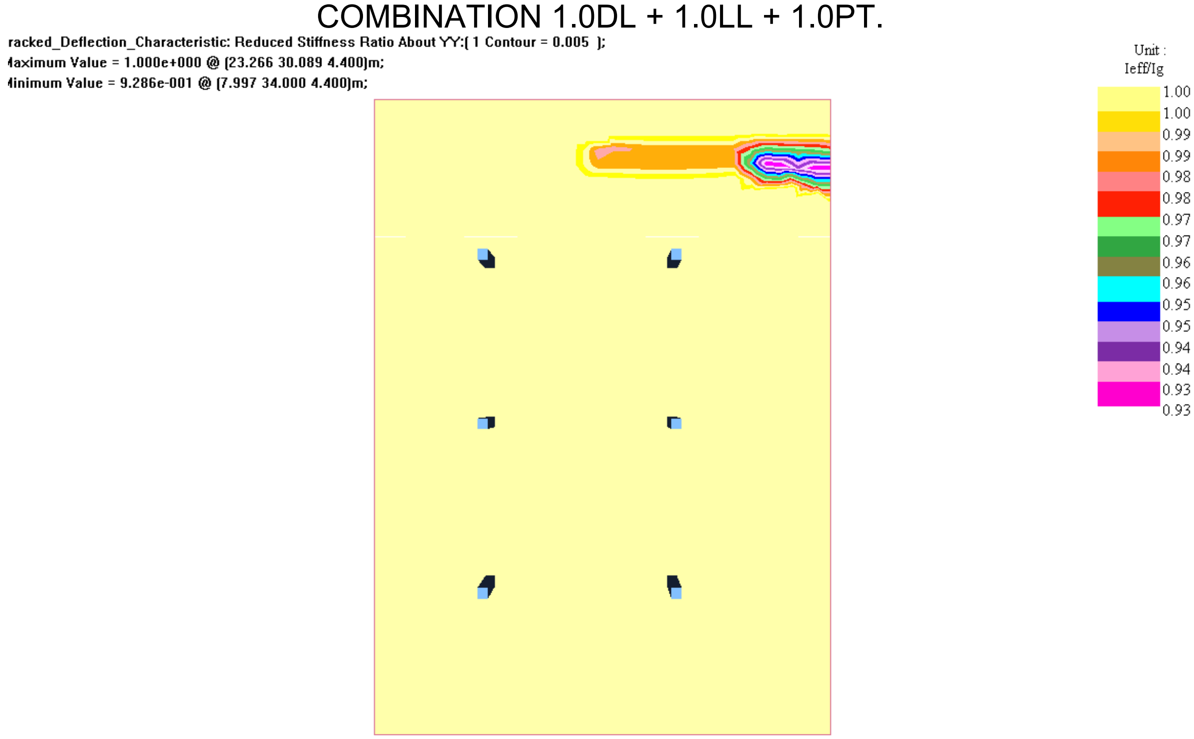


FIGURE S20-3.2 ILLUSTRATION OF LOCAL LOSS OF ROTATIONAL STIFFNESS ABOUT XX DUE TO CRACK FORAMTION UNDER CHARACTERISTIC (TOTAL) LOAD COMBINATION
1.0DL + 1.0LL + 1.0PT.

The reason of agreater loss of stiffness in the upper portion of the floor is the larger end span in that region. For the load combination specified, maximum loss of stiffness is 8% for moments about X-X (horizontal) axis and 7% about Y-Y axis.

LONG-TERM DEFLECTION

Since the cracking in the structure for the “total load” combination (above) is relatively small, and that there will be no cracking at the location of maximum deflection under the “sustained” load combination, the long-term deflection is essentially that due to instantaneous deflection of the sustained load combination adjusted for creep and shrinkage.

Sustained load combination: 1.0DL + 0.25LL + 1.0Prestressing

The maximum instantaneous deflection due to sustained load combination (diagram below) is 18.0 mm. Hence the estimated long term deflection would be:

Estimated long-term deflection = 18.0x 3 = 54 mm.

It is important to note that for code compliance and acceptability of long-term deflection, one has to determine the fraction of deflection that takes place subsequent to installation of non-structural elements that are likely to be damaged.[3]

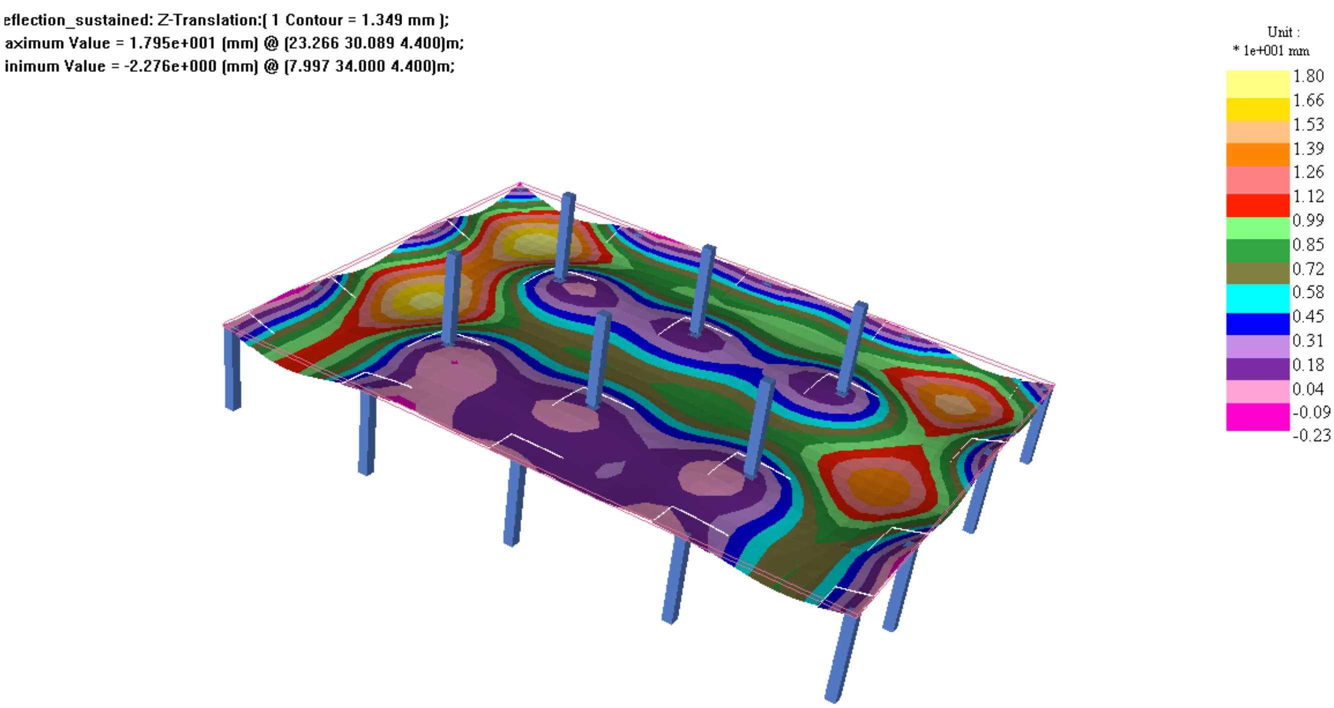


FIGURE S20-4 ILLUSTRATION OF INSTANTANEOUS DEFLECTION UNDER SUSTAINED LOAD COMBINATION: 1.0DL + 0.25LL + 1.0PT.

[3] ADAPT Technical Note TN292 Deflection of Concrete Floors

DEFLECTION DUE TO LIVE LOAD
The maximum deflection due to the application of the entire live load was calculated to be 11.5 mm

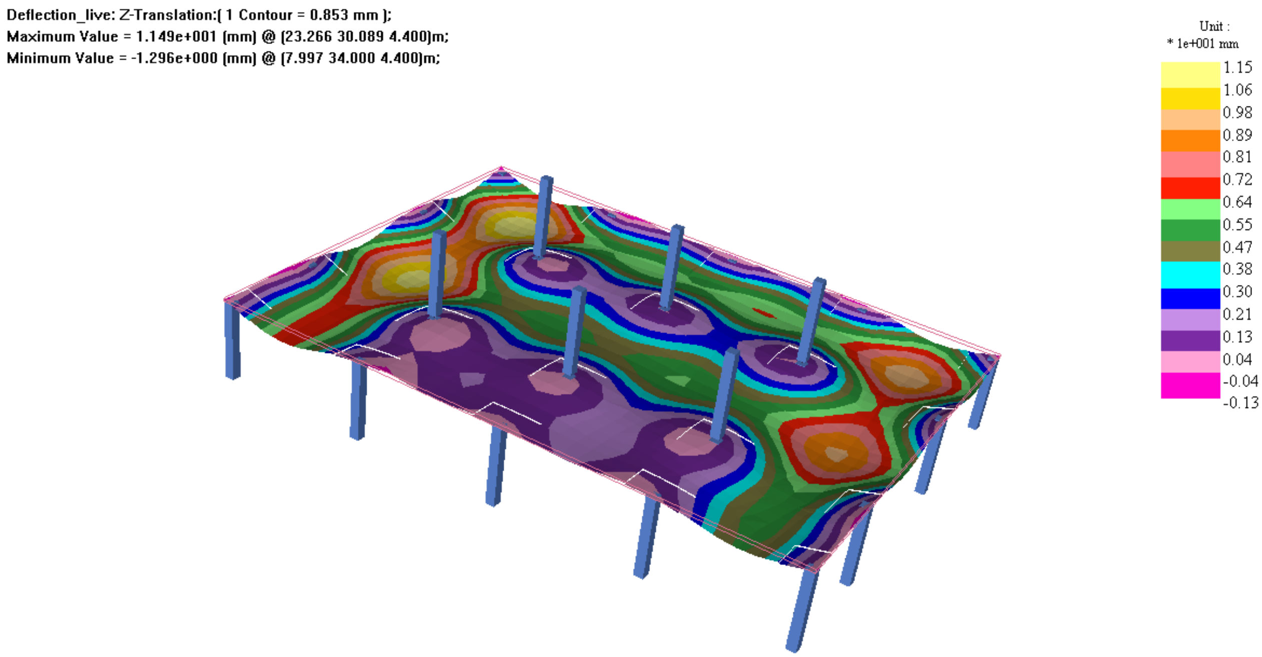


FIGURE S21 ILLUSTRATION OF DEFLECTION DUE TO LIVE LOAD

S22 – SUPPORT LINES IN X-DIRECTION

The identification of the support lines used for design and the span lengths are shown in the following two figures.

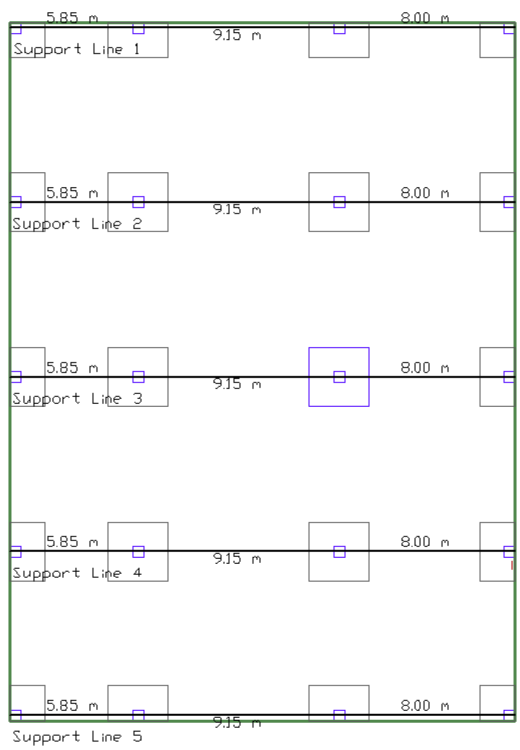


FIGURE S22-1 VIEW OF SUPPORT LINES AND SUPPORT LINE SPACING ALONG X-DIRECITON

S23 – SUPPORT LINES IN Y-DIRECTION

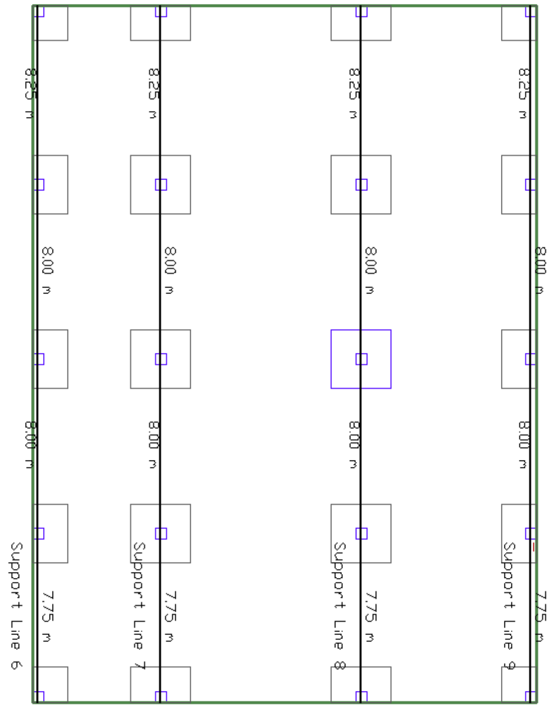


FIGURE S23-1 VIEW OF SUPPORT LINES AND SUPPORT LINE SPACING ALONG Y-DIRECITON

S24 and S25 DESIGN STRIPS IN THE TWO ORTHOGONAL DIRECTIONS

The following two figures show the break down of the floor system into design strips for design purposes,

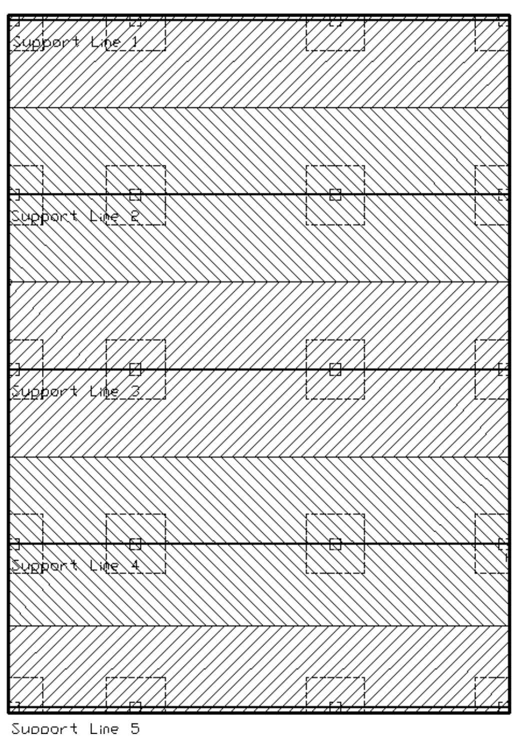


FIGURE S24-1 DEIGN STRIPS IN X-DIRECTION

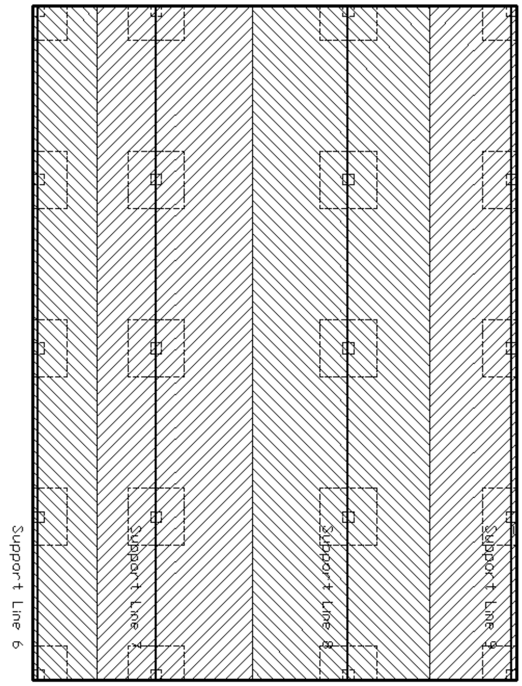


FIGURE S25-1 DEIGN STRIPS IN Y-DIRECTION

S26 AND S27 DISTRIBUTION OF DESIGN MOMENTS AND DESGIN STRIP STRESSES

The following two figures show the distribution of design moments (strength combination) for each of the design strips.

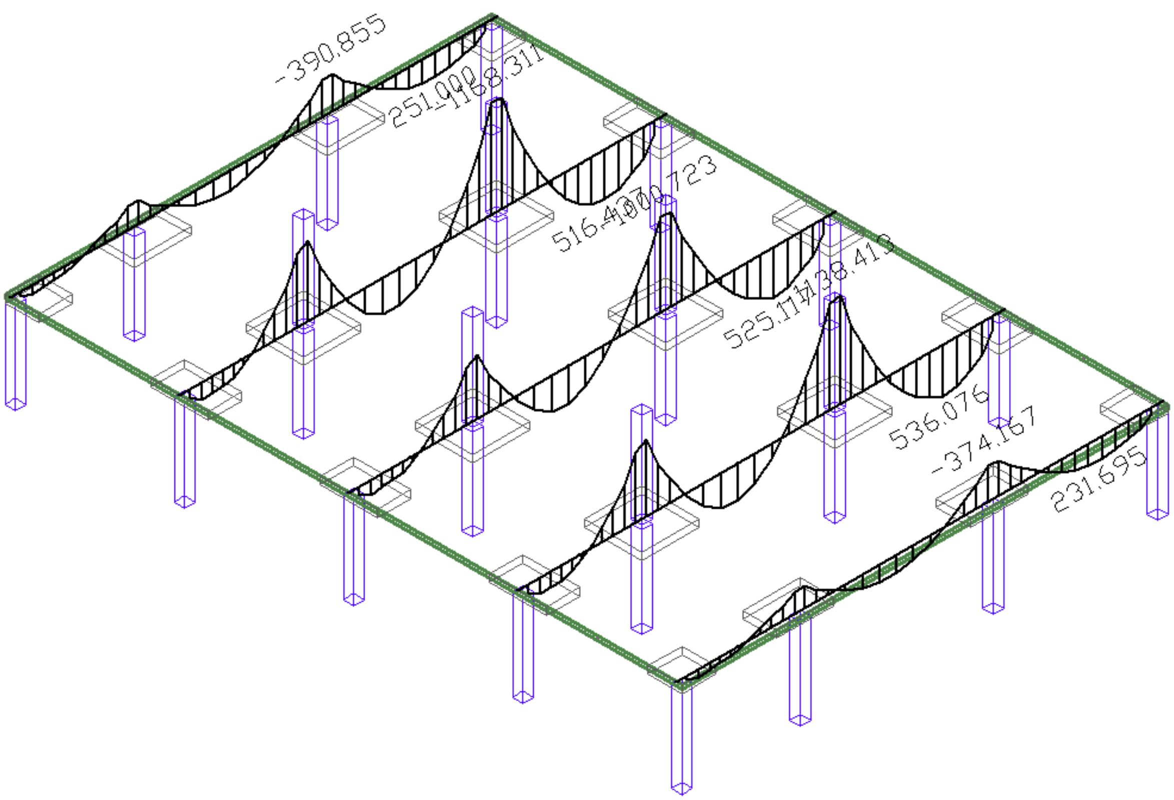


FIGURE S26-1 DISTRIBUTION OF DESIGN MOMENTS ALONG X-X DIRECTION

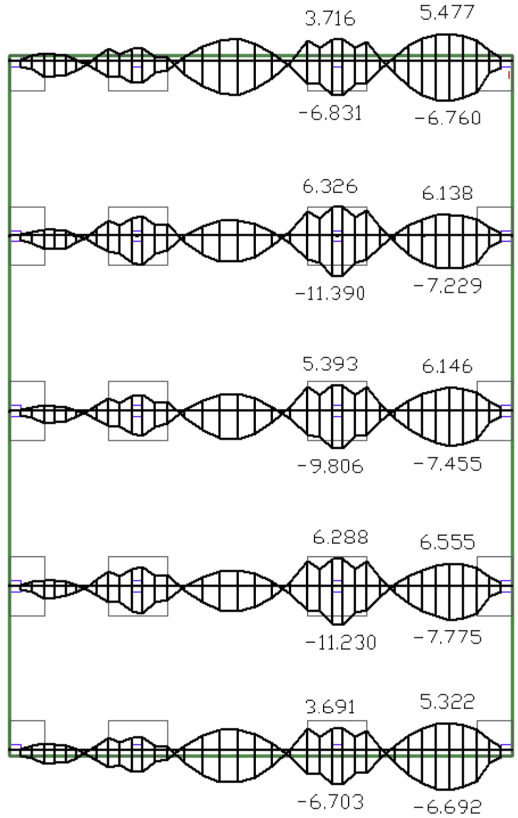


FIGURE S26-2 DISTRIBUTION OF DESIGN STRESSES ALONG X-DIRECTION
(tension positive; compression negative; values in MPa)

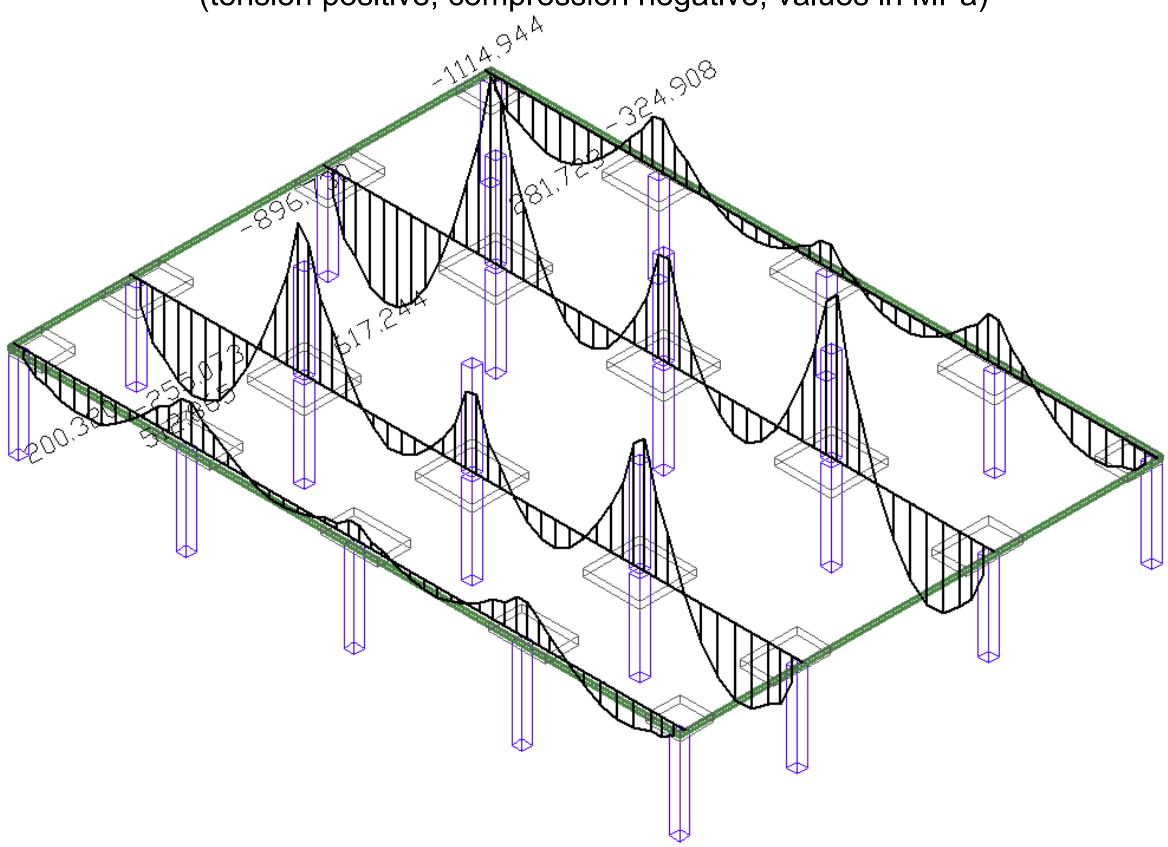


FIGURE S27-1 DISTRIBUTION OF DESIGN MOMENTS ALONG Y-DIRECTION

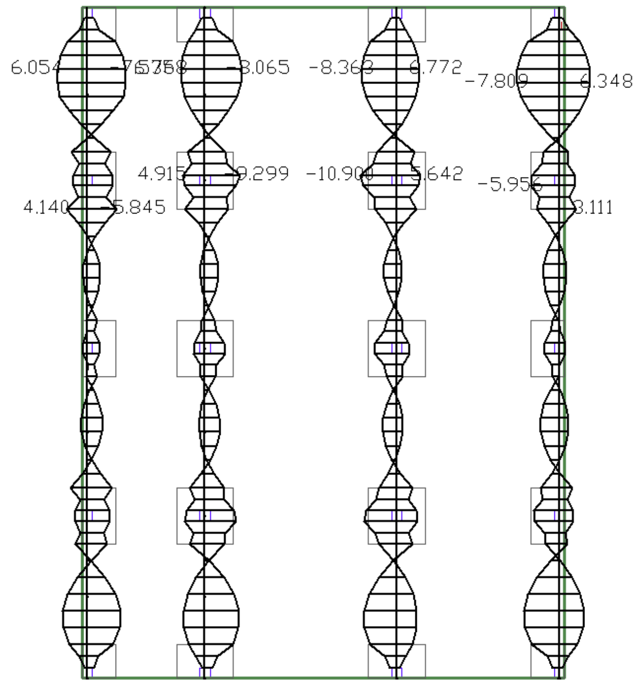


FIGURE S27-2 DISTRIBUTION OF DESIGN STRESSES ALONG Y-DIRECTION
(tension positive; compression negative; values in MPa)

S28 AND S29 STRESS CHECKDIAGRAMS FOR X- AND Y-DIRECTIONS

The following two figures show the outcome of stress checks for each of the design sections. Broken lines, if any, indicate the location where stresses exceed the code allowable values. Details of stress check and stress values for each support line are shown in the following pages. Reinforcement is added, where computed tensile stresses exceed the specified threshold. Hence, in the following two figures all design sections are shown to have passed the stress check.

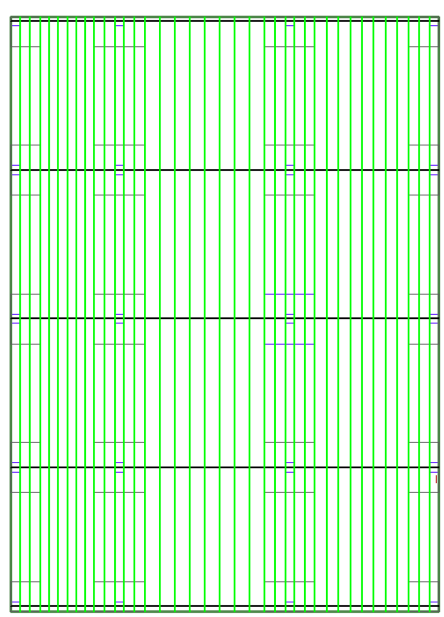


FIGURE S28-1 STRESS CHECK OUTCOME FOR SUPPORT LINES ALONG X-DIRECTION (All solid line OK)

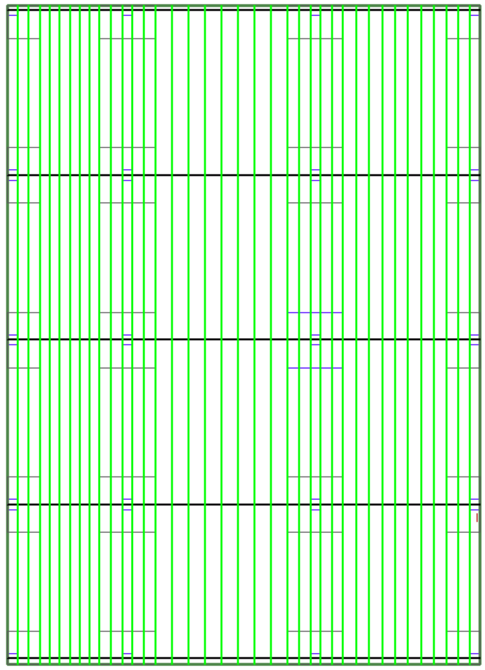
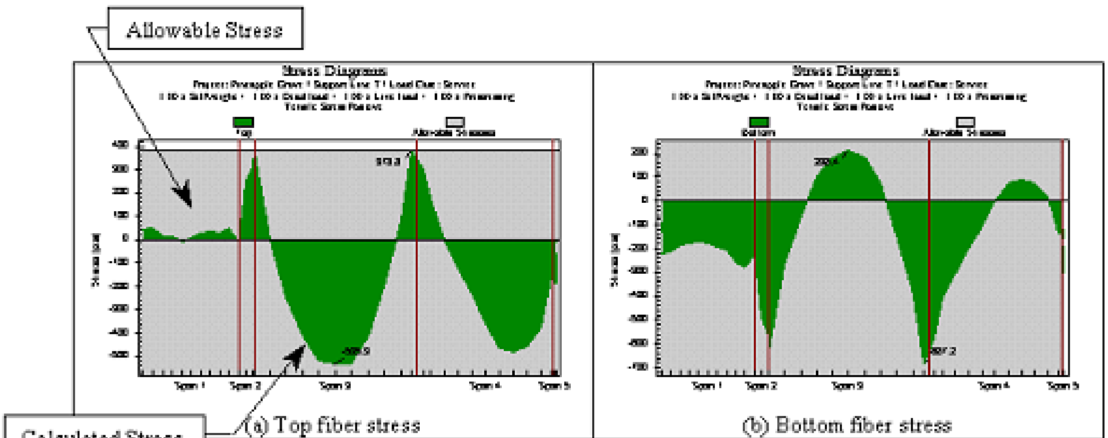


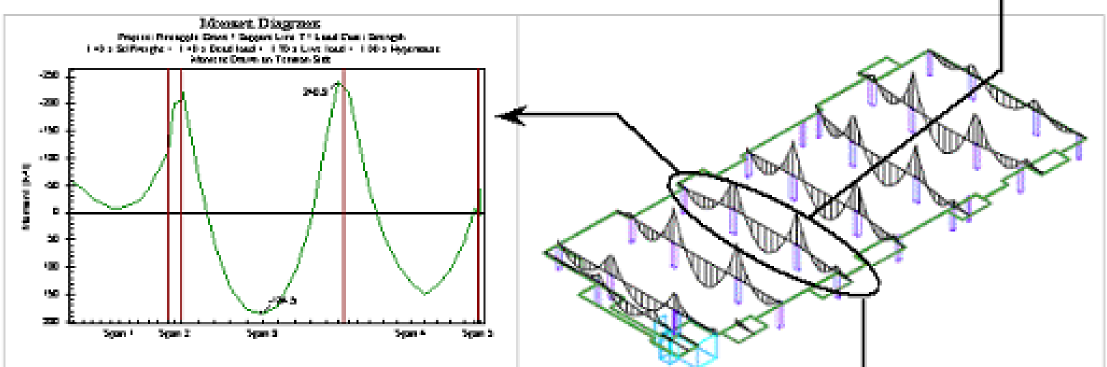
FIGURE S29-1 STRESS CHECK OUTCOME FOR SUPPORT LINES ALONG Y-DIRECTION (All solid lines, OK)

S30 – DESIGN SUMMARY LEGEND

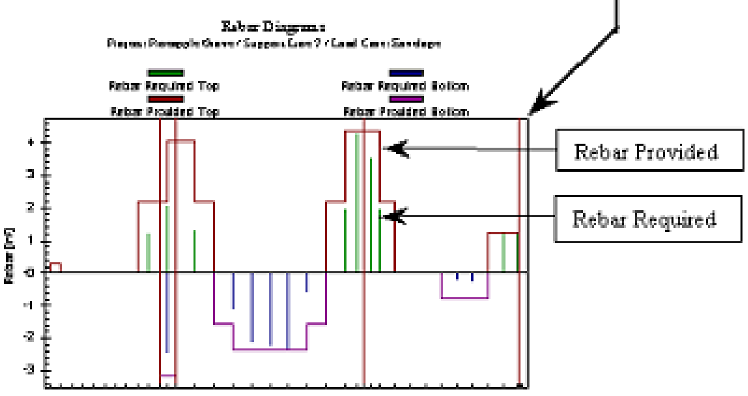
This legend is provided as an aid for the interpretation of the results that follow. In the following, each page reflects the design outcome and summary of one of the support lines. The summary includes stress check, distribution of design moment, and the total reinforcement for each design strip



DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)



DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)

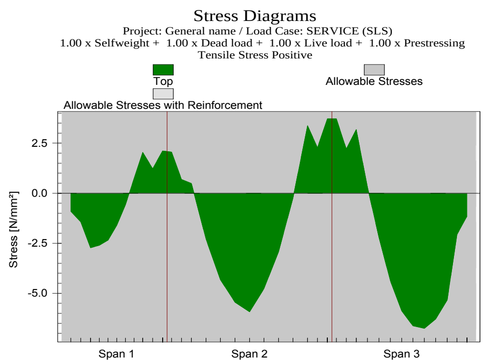


DESIGN STRIP REINFORCEMENT
REQUIRED AND PROVIDED

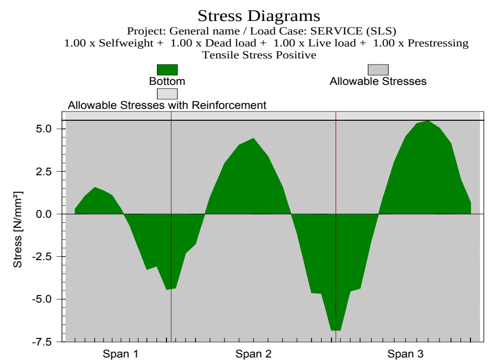
S31 – DEISGN SUMMARY OF INDIVIDUAL DESIGN STRIPS

Calculated stress is shown against the background of allowable values. The threshold for Class 3 design is marked with a horizontal line at 5.5 MPa tension. Required rebar is shown by the bar chart at the bottom. The provided rebar is shown by the envelope covering the required values

DESIGN STRIP 1

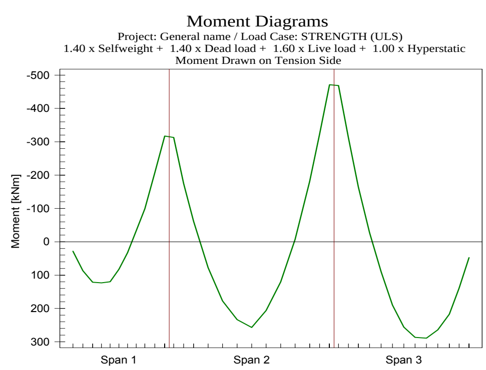


(a) Max tension 3.7 N/mm2, Allowable 5.5 N/mm2
Max compression -6.8 N/mm2, Allowable 13.2 N/mm2

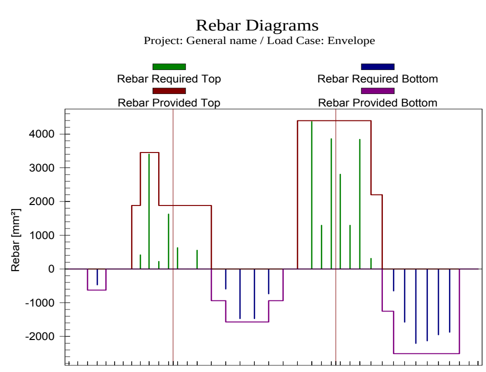


(b) Max tension 5.5 N/mm2, Allowable 5.5 N/mm2
Max compression -6.8 N/mm2, Allowable 13.2 N/mm2

DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)

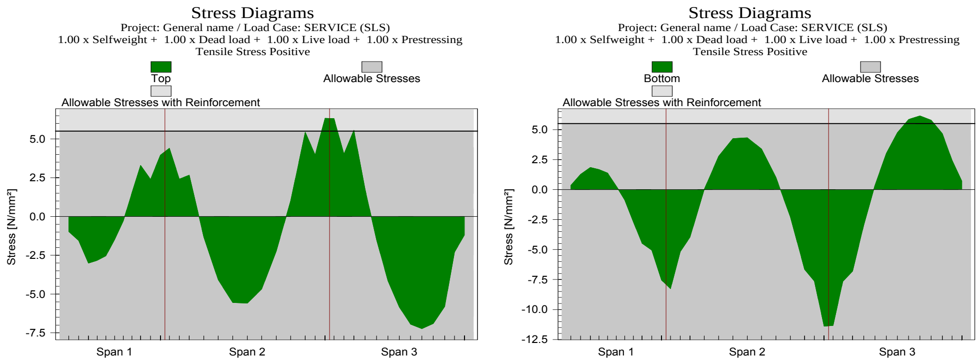


DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT REQUIRED AND PROVIDED

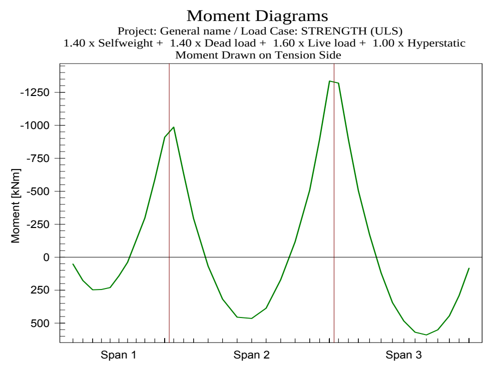
DESIGN STRIP 2



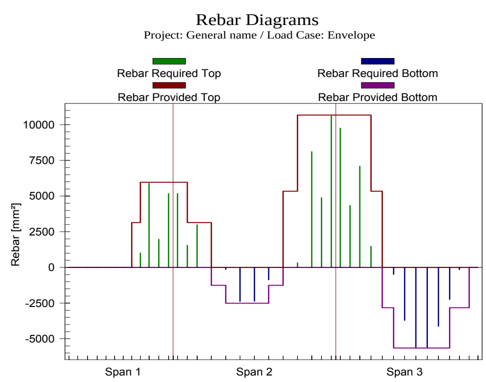
(a) Max tension 6.3 N/mm2, Allowable 5.5 N/mm2
Max compression -7.2 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 6.1 N/mm2, Allowable 5.5 N/mm2
Max compression -11.4 N/mm2, Allowable 13.2 N/mm2

DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)

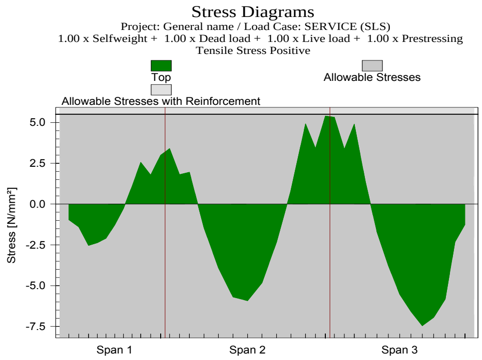


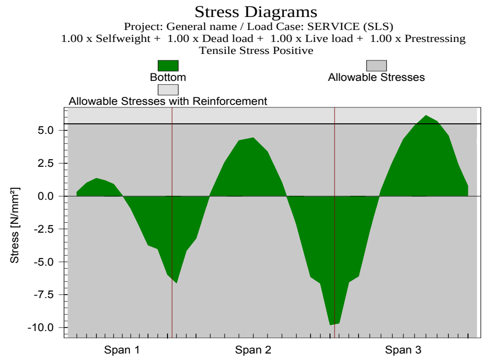
DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT REQUIRED AND PROVIDED

DESIGN STRIP 3

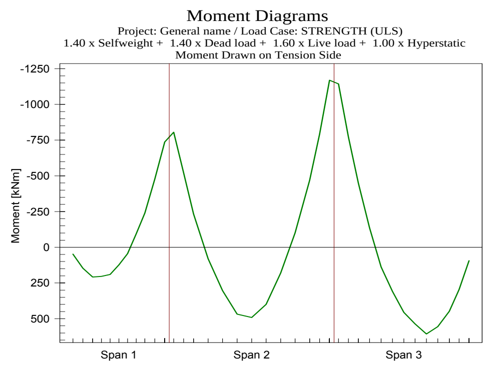




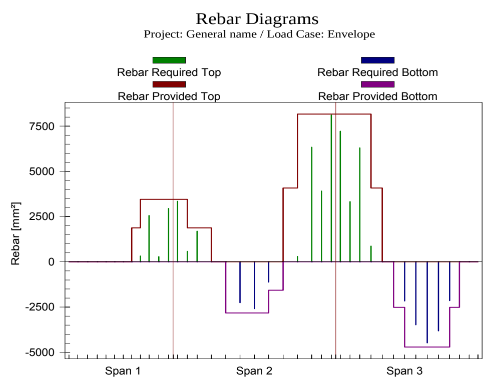
(a) Max tension 5.4 N/mm2, Allowable 5.5 N/mm2
Max compression -7.5 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 6.1 N/mm2, Allowable 5.5 N/mm2
Max compression -9.8 N/mm2, Allowable 13.2 N/mm2

DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)

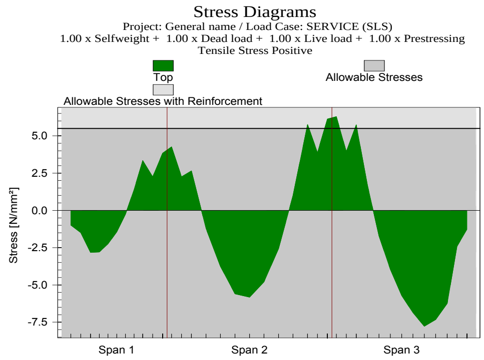


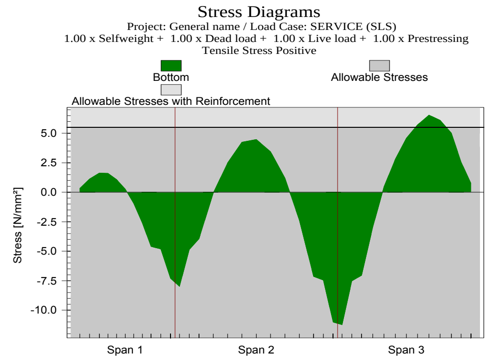
DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT REQUIRED AND PROVIDED

DESIGN STRIP 4

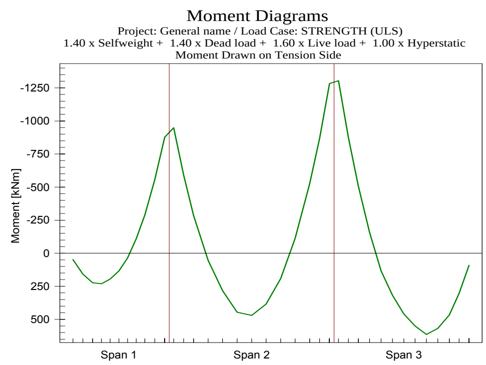




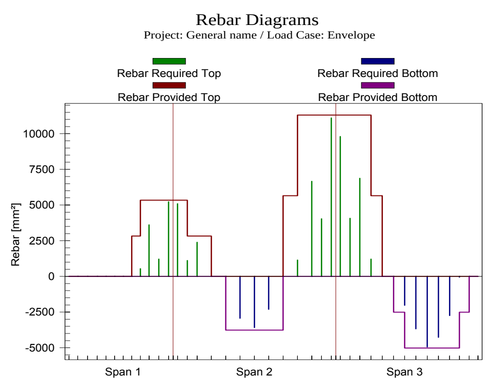
(a) Max tension 6.3 N/mm2, Allowable 5.5 N/mm2
Max compression -7.8 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 6.6 N/mm2, Allowable 5.5 N/mm2
Max compression -11.2 N/mm2, Allowable 13.2 N/mm2

DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)

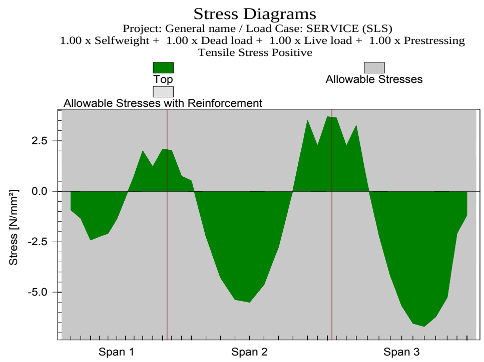


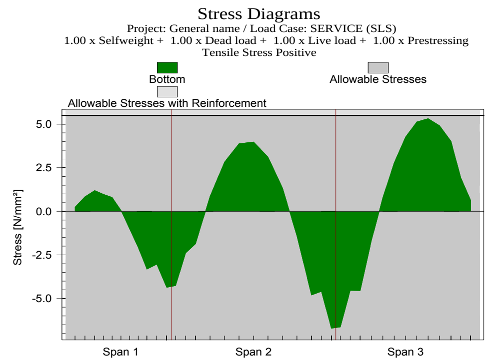
DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT
REQUIRED AND PROVIDED

DESIGN STRIP 5

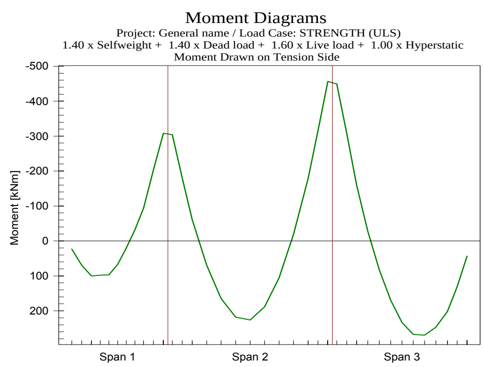




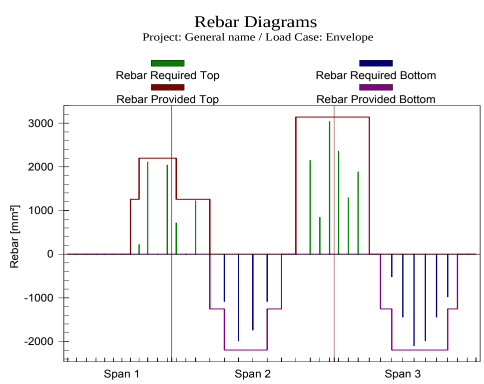
(a) Max tension 3.7 N/mm2, Allowable 5.5 N/mm2
Max compression -6.7 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 5.3 N/mm2, Allowable 5.5 N/mm2
Max compression -6.7 N/mm2, Allowable 13.2 N/mm2

DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)

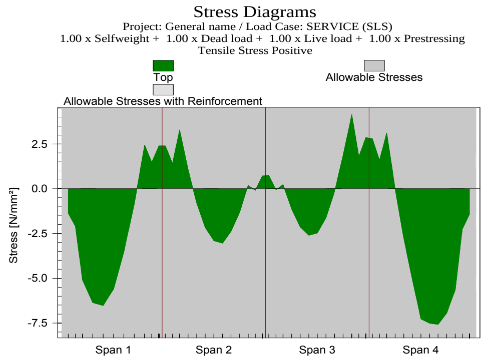


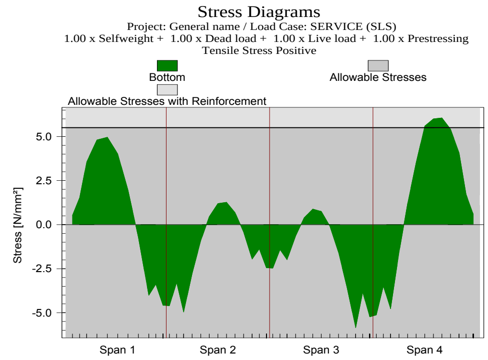
DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT REQUIRED AND PROVIDED

DESIGN STRIP 6

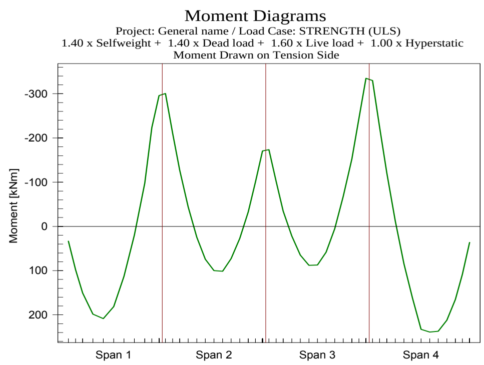




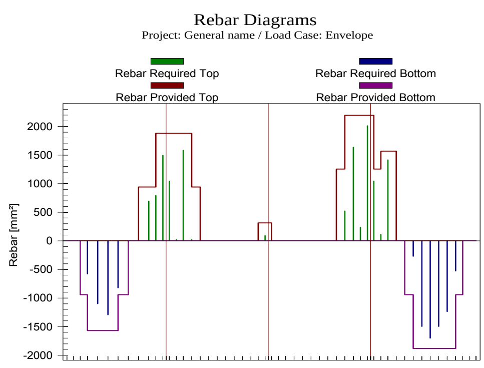
(a) Max tension 4.1 N/mm2, Allowable 5.5 N/mm2
Max compression -7.6 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 6.1 N/mm2, Allowable 5.5 N/mm2
Max compression -5.8 N/mm2, Allowable 13.2 N/mm2

DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)

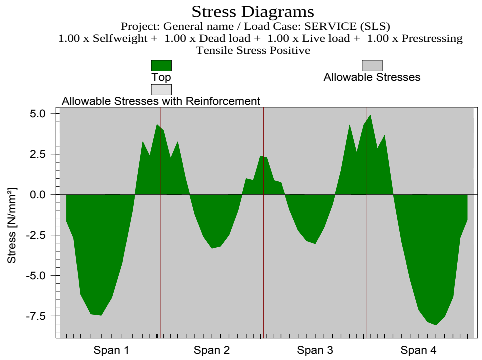


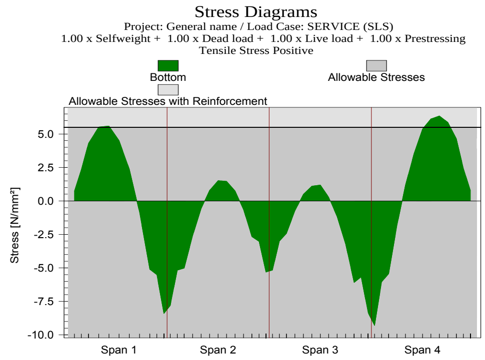
DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT
REQUIRED AND PROVIDED

DESIGN STRIP 7



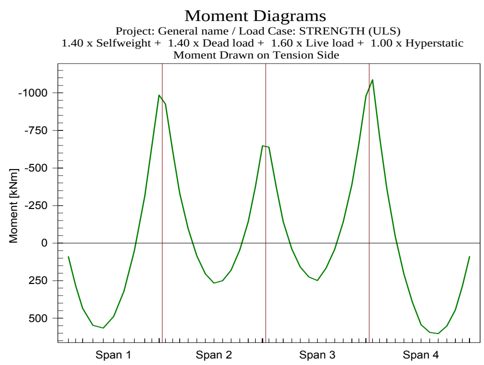


(a) Max tension 4.9 N/mm2, Allowable 5.5 N/mm2
Max compression -8.1 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 6.4 N/mm2, Allowable 5.5 N/mm2
Max compression -9.3 N/mm2, Allowable 13.2 N/mm2

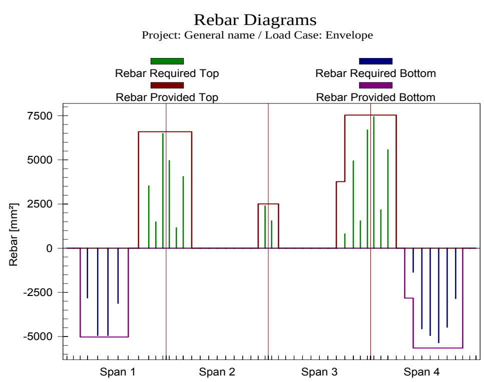
DESIGN STRIP SERVICE COMBINATION STRESSES

(Tension stress positive)



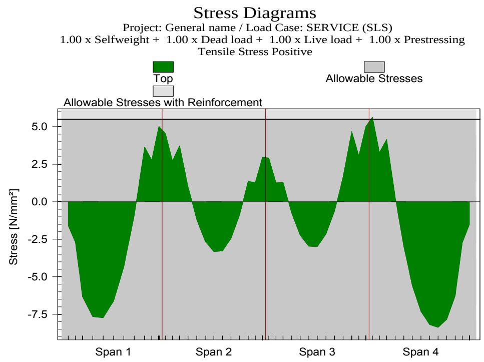
DESIGN STRIP "DESIGN MOMENT (Mu)"

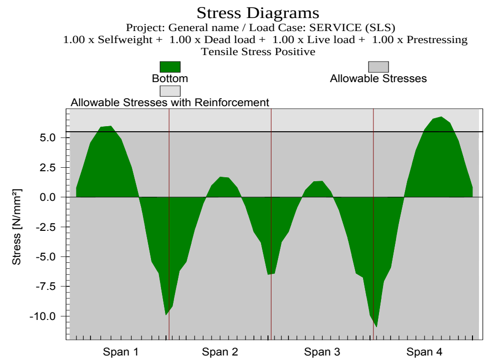
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT REQUIRED AND PROVIDED

DESIGN STRIP 8

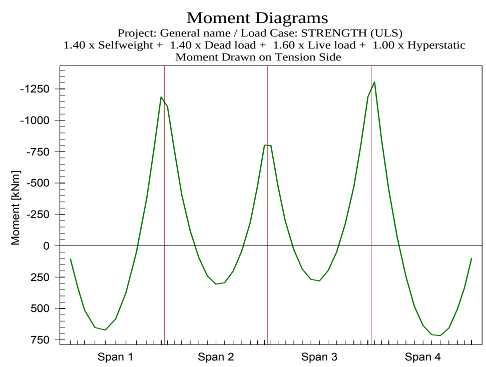




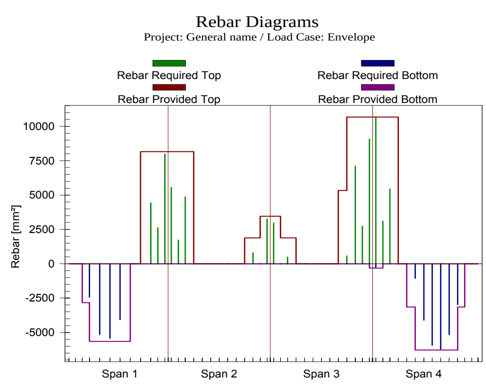
(a) Max tension 5.6 N/mm2, Allowable 5.5 N/mm2
Max compression -8.4 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 6.8 N/mm2, Allowable 5.5 N/mm2
Max compression -10.9 N/mm2, Allowable 13.2 N/mm2

DESIGN STRIP SERVICE COMBINATION STRESSES
(Tension stress positive)

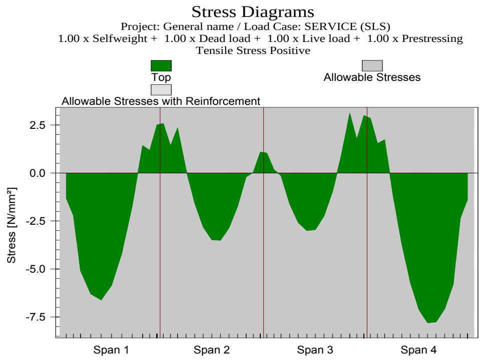


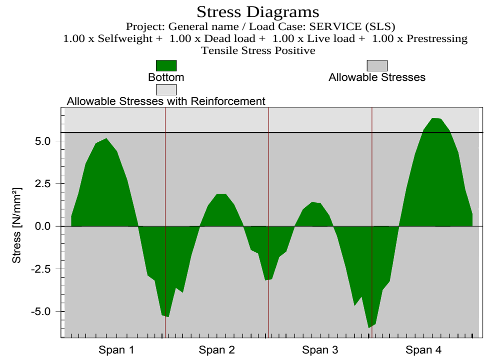
DESIGN STRIP "DESIGN MOMENT (Mu)"
(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT REQUIRED AND PROVIDED

DESIGN STRIP 9



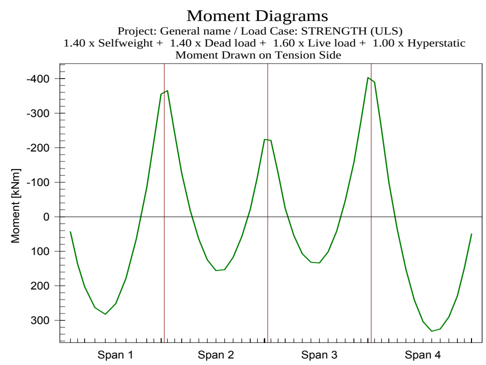


(a) Max tension 3.1 N/mm2, Allowable 5.5 N/mm2
Max compression -7.8 N/mm2, Allowable 13.2 N/mm2

(b) Max tension 6.3 N/mm2, Allowable 5.5 N/mm2
Max compression -6.0 N/mm2, Allowable 13.2 N/mm2

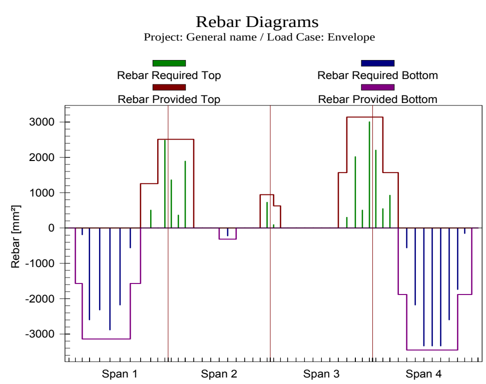
DESIGN STRIP SERVICE COMBINATION STRESSES

(Tension stress positive)



DESIGN STRIP "DESIGN MOMENT (Mu)"

(Moment is drawn on the tension side)



DESIGN STRIP REINFORCEMENT REQUIRED AND PROVIDED

S32 – REINFORCEMENT PLAN FROM COMPUTATION

Figure S32-1 shows the reinforcement as reported by the software. This figure forms the basis of the reinforcement shown on the construction drawings. In addition to the reinforcement shown in the figure, the construction drawings include trim bars and simplifications in layout.

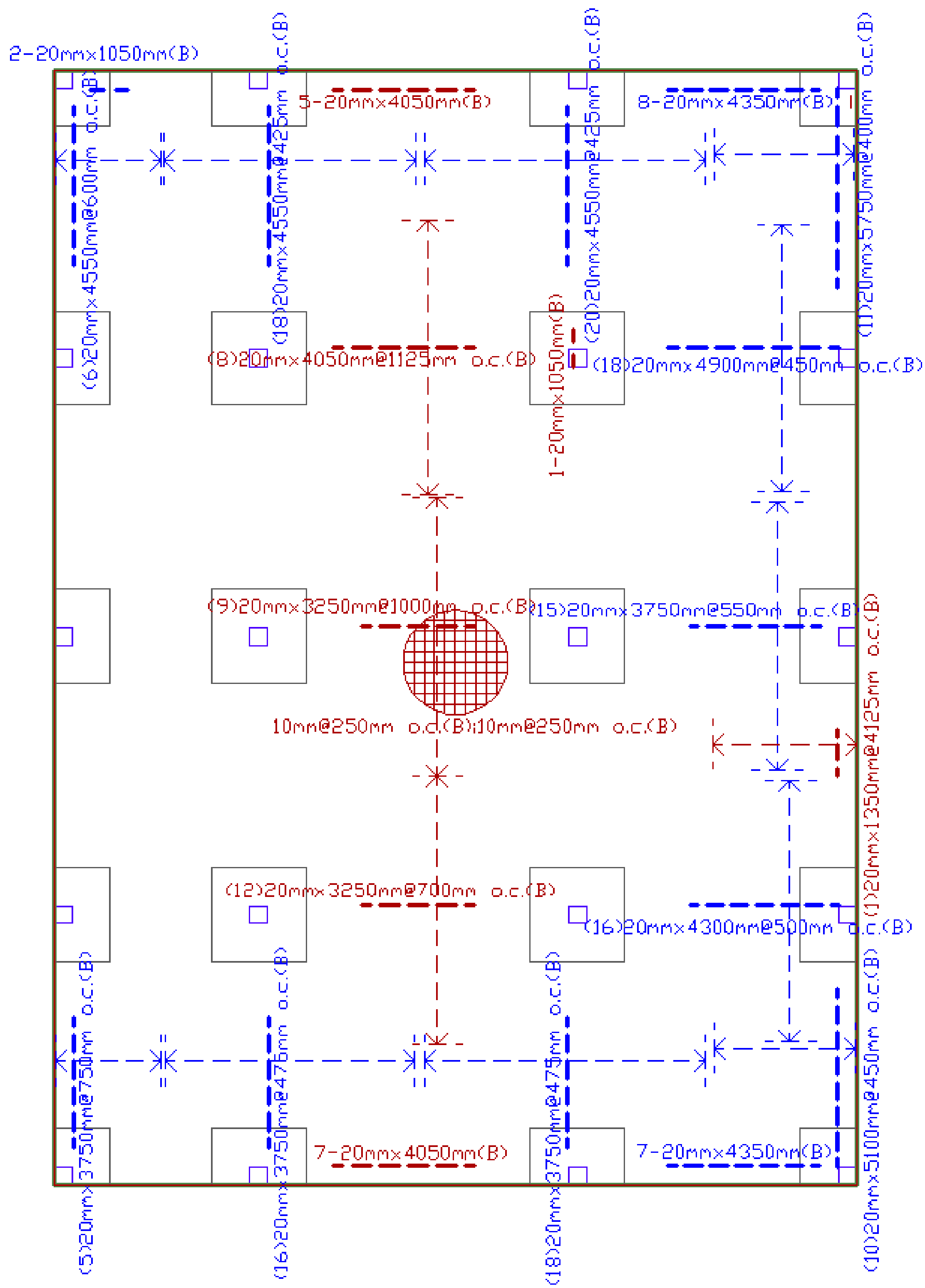


FIGURE S32-1 BOTTOM REINFORCEMENT

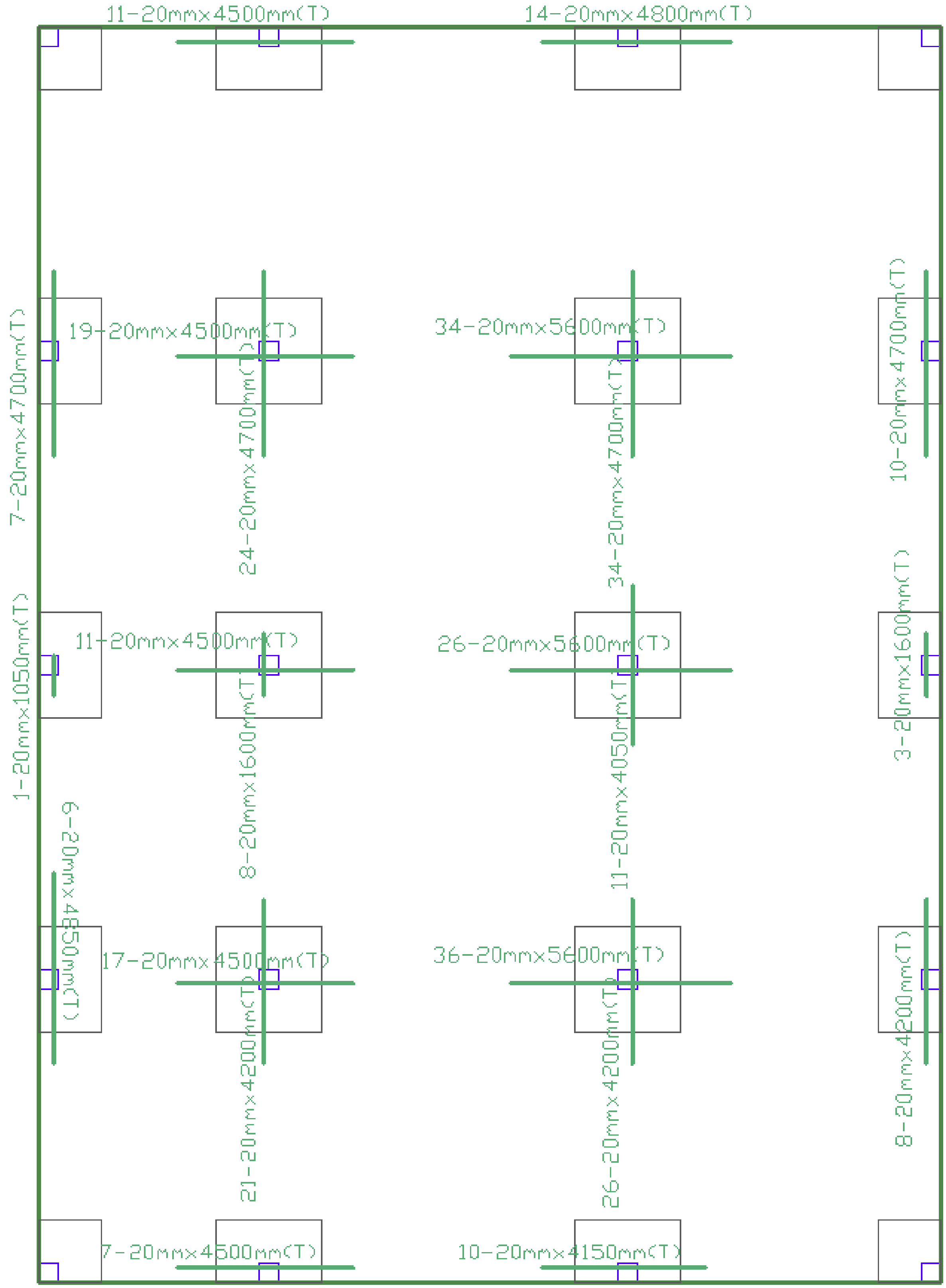


FIGURE S32-1 BOTTOM REINFORCEMENT

FIGURE S32-2 TOP REINFORCEMENT PLAN AS REPORTED BY DESIGN

S40 – COLUMN IDENTIFICATION PLAN

The bottom columns are identified in Fig. S40-1. These are numbered from 7 to 26.

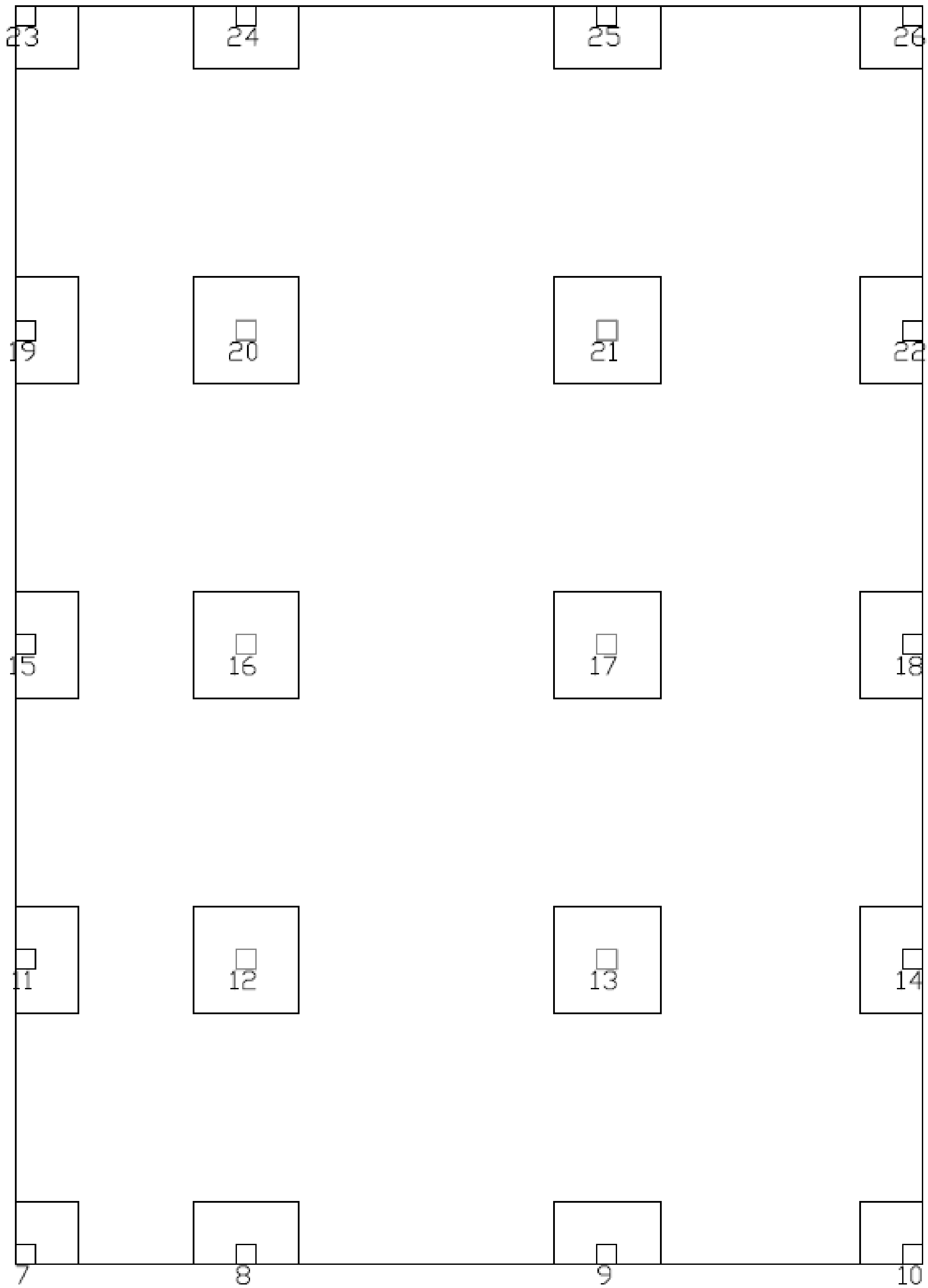


FIGURE S40-1 IDENTIFICATION OF LOWER COLUMNS

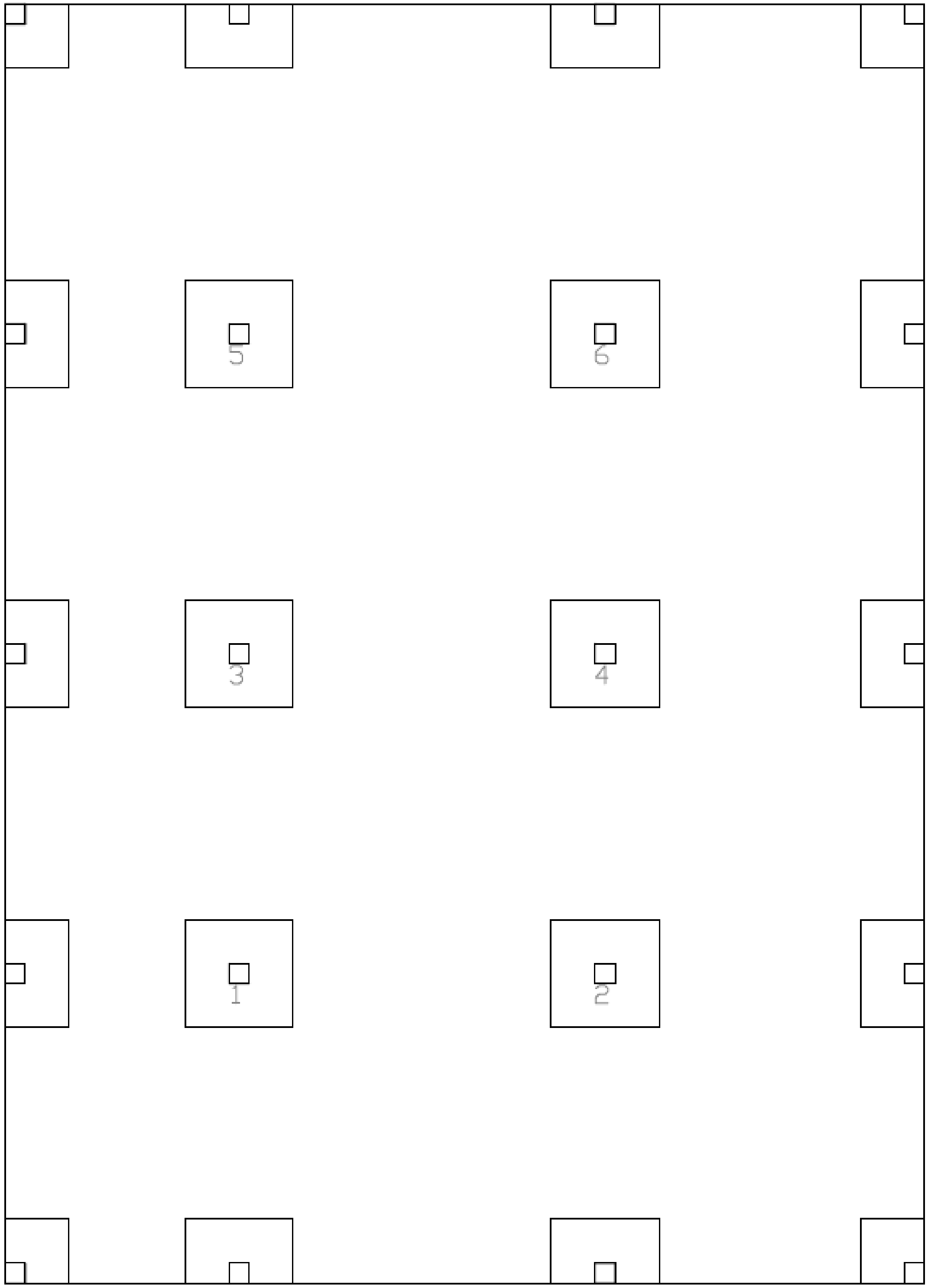
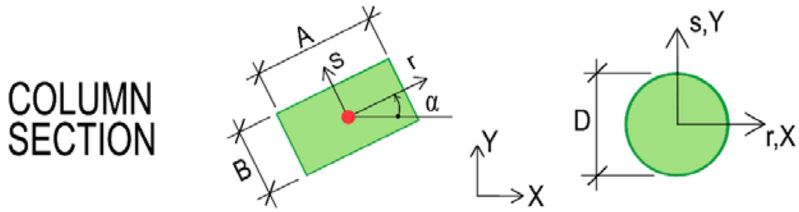


FIGURE S40-2 IDENTIFICATION OF UPPER COLUMNS

S41 – COLUMN REACTIONS



STRENGTH (ULS)

ID	Label	Fz	Fr	Fs	Mrr	Mss	Mzz
		kN	kN	kN	kN-m	kN-m	kN-m
7	Column 7	-132.600	0.000	0.000	0.000	0.000	0.000
8	Column 8	-490.800	0.000	-0.000	-0.000	0.000	0.000
9	Column 9	-582.870	-0.000	0.000	0.000	0.000	0.000
10	Column 10	-200.940	0.000	-0.000	-0.000	-0.000	0.000
11	Column 11	-370.620	-0.000	0.000	0.000	0.000	0.000
12	Column 12	-1493.300	-0.000	-0.000	42.276	48.112	0.000
13	Column 13	-1757.100	-0.000	0.000	46.277	13.264	0.000
14	Column 14	-533.750	0.000	0.000	0.000	-0.000	0.000
15	Column 15	-297.120	-0.000	0.000	0.000	0.000	0.000
16	Column 16	-1239.600	-0.000	0.000	5.877	45.607	0.000
17	Column 17	-1470.600	0.000	-0.000	6.018	13.232	0.000
18	Column 18	-444.390	0.000	0.000	0.000	-0.000	0.000
19	Column 19	-384.210	-0.000	0.000	0.000	0.000	0.000
20	Column 20	-1546.000	-0.000	0.000	-69.477	49.963	0.000
21	Column 21	-1821.500	-0.000	0.000	-73.313	14.383	0.000
22	Column 22	-553.650	0.000	0.000	0.000	-0.000	0.000
23	Column 23	-142.730	0.000	0.000	0.000	-0.000	0.000
24	Column 24	-523.240	0.000	0.000	0.000	-0.000	0.000
25	Column 25	-621.980	0.000	0.000	0.000	0.000	0.000
26	Column 26	-215.420	0.000	-0.000	-0.000	-0.000	0.000

SERVICE (SLS)

ID	Label	Fz	Fr	Fs	Mrr	Mss	Mzz
		kN	kN	kN	kN-m	kN-m	kN-m
7	Column 7	-91.353	0.000	0.000	0.000	0.000	0.000
8	Column 8	-335.070	0.000	0.000	0.000	0.000	0.000
9	Column 9	-397.640	0.000	0.000	0.000	0.000	0.000
10	Column 10	-137.760	0.000	0.000	0.000	0.000	0.000
11	Column 11	-252.970	0.000	0.000	0.000	0.000	0.000
12	Column 12	-1008.900	-0.000	0.000	27.644	33.289	0.000
13	Column 13	-1187.300	-0.000	0.000	30.358	8.108	0.000
14	Column 14	-362.620	0.000	0.000	0.000	0.000	0.000
15	Column 15	-204.120	0.000	0.000	0.000	0.000	0.000
16	Column 16	-841.700	-0.000	0.000	3.828	31.567	0.000
17	Column 17	-998.290	-0.000	0.000	3.936	8.158	0.000
18	Column 18	-303.530	0.000	0.000	0.000	0.000	0.000
19	Column 19	-262.080	0.000	0.000	0.000	0.000	0.000
20	Column 20	-1044.700	-0.000	-0.000	-46.243	34.454	0.000
21	Column 21	-1231.100	-0.000	-0.000	-48.783	8.935	0.000
22	Column 22	-376.060	0.000	0.000	0.000	0.000	0.000
23	Column 23	-98.147	0.000	0.000	0.000	0.000	0.000
24	Column 24	-356.880	0.000	0.000	0.000	0.000	0.000
25	Column 25	-423.940	0.000	0.000	0.000	0.000	0.000

26	Column 26	-147.510	0.000	0.000	0.000	0.000	0.000

PRESTRESS

ID	Label	Fz	Fr	Fs	Mrr	Mss	Mzz
		kN	kN	kN	kN-m	kN-m	kN-m
7	Column 7	-2.777	0.000	0.000	0.000	0.000	0.000
8	Column 8	-5.929	0.000	0.000	0.000	0.000	0.000
9	Column 9	-6.796	0.000	0.000	0.000	0.000	0.000
10	Column 10	-3.255	0.000	0.000	0.000	0.000	0.000
11	Column 11	-3.471	0.000	0.000	0.000	0.000	0.000
12	Column 12	14.641	-0.000	-0.000	-3.088	2.396	0.000
13	Column 13	14.713	0.000	0.000	-3.032	-2.818	0.000
14	Column 14	-1.228	0.000	0.000	0.000	0.000	0.000
15	Column 15	-6.379	0.000	0.000	0.000	0.000	0.000
16	Column 16	0.486	-0.000	0.000	-0.457	2.309	0.000
17	Column 17	-0.706	0.000	-0.000	-0.423	-2.578	0.000
18	Column 18	-5.631	0.000	0.000	0.000	0.000	0.000
19	Column 19	-3.232	0.000	0.000	0.000	0.000	0.000
20	Column 20	14.093	-0.000	-0.000	2.459	2.129	0.000
21	Column 21	14.165	0.000	0.000	2.617	-2.584	0.000
22	Column 22	-1.147	0.000	0.000	0.000	0.000	0.000
23	Column 23	-2.582	0.000	0.000	0.000	0.000	0.000
24	Column 24	-5.515	0.000	0.000	0.000	0.000	0.000
25	Column 25	-6.309	0.000	0.000	0.000	0.000	0.000
26	Column 26	-3.141	0.000	0.000	0.000	0.000	0.000

SWGT

ID	Label	Fz	Fr	Fs	Mrr	Mss	Mzz
		kN	kN	kN	kN-m	kN-m	kN-m
7	Column 7	-58.920	0.000	0.000	0.000	0.000	0.000
8	Column 8	-191.210	0.000	0.000	0.000	0.000	0.000
9	Column 9	-223.540	0.000	0.000	0.000	0.000	0.000
10	Column 10	-83.168	0.000	0.000	0.000	0.000	0.000
11	Column 11	-149.380	0.000	0.000	0.000	0.000	0.000
12	Column 12	-592.980	-0.000	0.000	16.818	15.641	0.000
13	Column 13	-686.630	-0.000	0.000	18.045	6.502	0.000
14	Column 14	-208.390	0.000	0.000	0.000	0.000	0.000
15	Column 15	-121.030	0.000	0.000	0.000	0.000	0.000
16	Column 16	-495.110	-0.000	0.000	2.245	14.791	0.000
17	Column 17	-576.420	-0.000	0.000	2.309	6.306	0.000
18	Column 18	-174.020	0.000	0.000	0.000	0.000	0.000
19	Column 19	-154.250	0.000	0.000	0.000	0.000	0.000
20	Column 20	-611.720	-0.000	-0.000	-26.142	16.373	0.000
21	Column 21	-709.180	-0.000	-0.000	-27.495	6.716	0.000
22	Column 22	-215.560	0.000	0.000	0.000	0.000	0.000
23	Column 23	-62.633	0.000	0.000	0.000	0.000	0.000
24	Column 24	-202.890	0.000	0.000	0.000	0.000	0.000
25	Column 25	-237.690	0.000	0.000	0.000	0.000	0.000
26	Column 26	-88.389	0.000	0.000	0.000	0.000	0.000

S42 – PUNCHING SHEAR PLAN

Figure S42-1 shows the stress check (SR) ratios for each of the punching shear locations checked. Where stress ratios exceed 1, punching shear reinforcement will be provided and reported in section S43. Details of stress ratios are shown in Table S42-1. The punching shear stresses calculated are based on the minimum top bar requirements of the code. If based on the calculated reinforcement, the stress ratios will be less. .

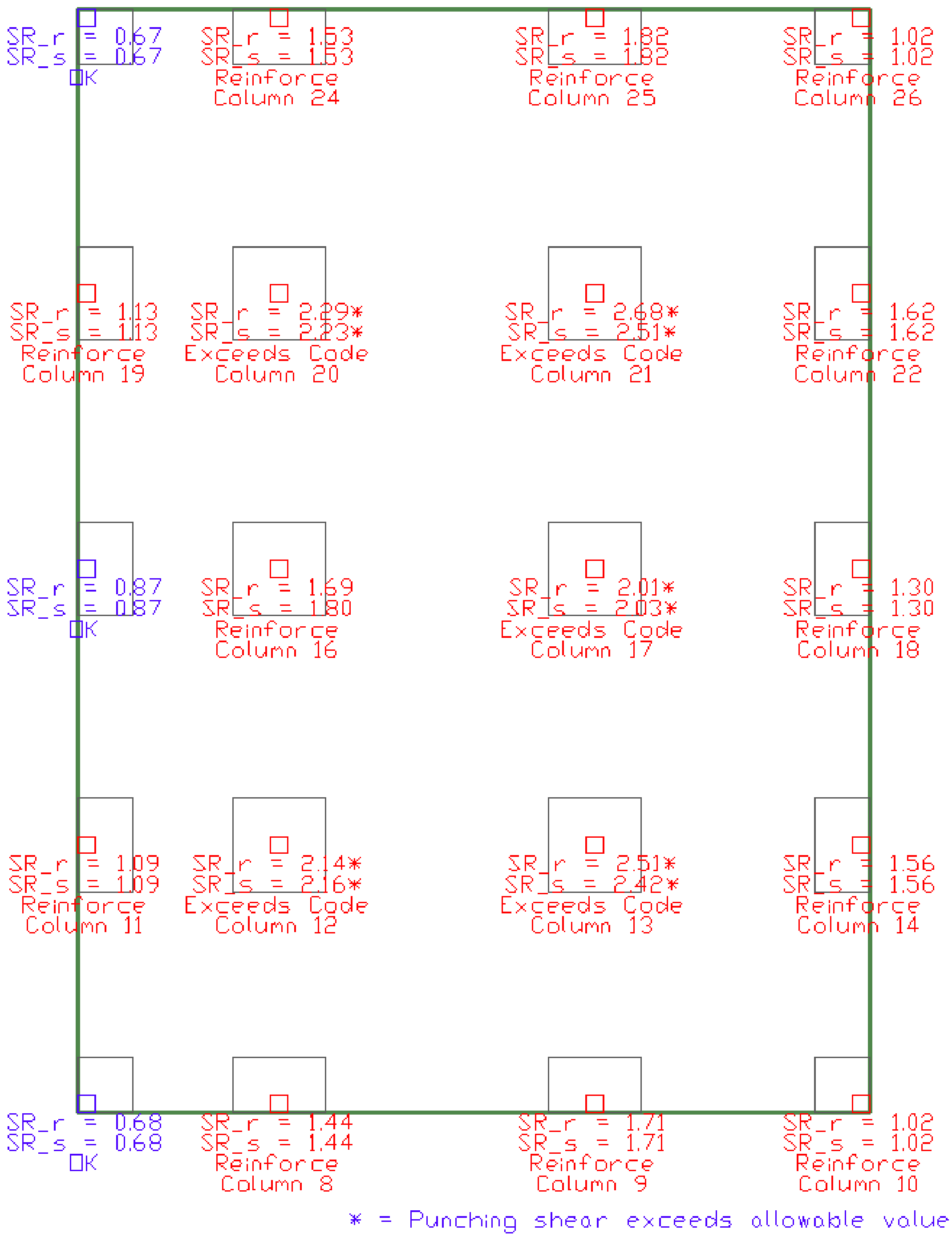
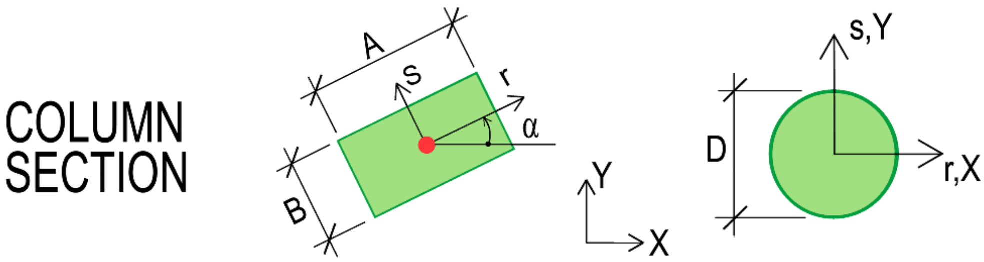


FIGURE S42 -1 PUNCHING SHEAR STRESS RATIOS

180.40 PUNCHING SHEAR STRESS CHECK RESULTS



Load Combination:STRENGTH (ULS)

Label	Condition	Axis	Factored shear	Factored moment	Stress due to shear	Stress due to moment	Total stress	Allowable stress	Stress ratio
			kN	kN-m	MPa	MPa	MPa	MPa	
Column 7	Corner	rr	-132.600	0.000	0.28	0.00	0.28	0.42	0.68
Column 7	Corner	ss	-132.600	0.000	0.28	0.00	0.28	0.42	0.68
Column 8	End	rr	-490.800	-0.000	0.60	0.00	0.60	0.42	1.44
Column 8	Edge	ss	-490.800	0.000	0.60	0.00	0.60	0.42	1.44
Column 9	Edge	rr	-582.870	0.000	0.72	0.00	0.72	0.42	1.71
Column 9	End	ss	-582.870	0.000	0.72	0.00	0.72	0.42	1.71
Column 10	Corner	rr	-200.940	-0.000	0.43	0.00	0.43	0.42	1.02
Column 10	Corner	ss	-200.940	-0.000	0.43	0.00	0.43	0.42	1.02
Column 11	Edge	rr	-370.620	0.000	0.46	0.00	0.46	0.42	1.09
Column 11	End	ss	-370.620	0.000	0.46	0.00	0.46	0.42	1.09
Column 12	Interior	rr	-1465.000	82.675	0.85	0.05	0.90	0.42	2.14
Column 12	Interior	ss	-1465.000	94.086	0.85	0.06	0.91	0.42	2.16
Column 13	Interior	rr	-1728.800	90.497	1.00	0.06	1.06	0.42	2.51
Column 13	Interior	ss	-1728.800	25.938	1.00	0.02	1.02	0.42	2.42
Column 14	Edge	rr	-533.750	0.000	0.66	0.00	0.66	0.42	1.56
Column 14	End	ss	-533.750	-0.000	0.66	0.00	0.66	0.42	1.56
Column 15	Edge	rr	-297.120	0.000	0.37	0.00	0.37	0.42	0.87
Column 15	End	ss	-297.120	0.000	0.37	0.00	0.37	0.42	0.87
Column 16	Interior	rr	-1211.300	11.492	0.70	0.01	0.71	0.42	1.69
Column 16	Interior	ss	-1211.300	89.187	0.70	0.05	0.76	0.42	1.80
Column 17	Interior	rr	-1442.300	11.769	0.84	0.01	0.84	0.42	2.01
Column 17	Interior	ss	-1442.300	25.876	0.84	0.02	0.85	0.42	2.03
Column 18	Edge	rr	-444.390	0.000	0.55	0.00	0.55	0.42	1.30
Column 18	End	ss	-444.390	-0.000	0.55	0.00	0.55	0.42	1.30
Column 19	Edge	rr	-384.210	0.000	0.47	0.00	0.47	0.42	1.13
Column 19	End	ss	-384.210	0.000	0.47	0.00	0.47	0.42	1.13
Column 20	Interior	rr	-1517.700	-135.870	0.88	0.08	0.96	0.42	2.29
Column 20	Interior	ss	-1517.700	97.705	0.88	0.06	0.94	0.42	2.23
Column 21	Interior	rr	-1793.200	-143.370	1.04	0.09	1.13	0.42	2.68
Column 21	Interior	ss	-1793.200	28.127	1.04	0.02	1.06	0.42	2.51
Column 22	Edge	rr	-553.650	0.000	0.68	0.00	0.68	0.42	1.62
Column 22	End	ss	-553.650	-0.000	0.68	0.00	0.68	0.42	1.62
Column 23	Corner	rr	-142.730	0.000	0.34	0.00	0.34	0.50	0.67
Column 23	Corner	ss	-142.730	-0.000	0.34	0.00	0.34	0.50	0.67
Column 24	Edge	rr	-523.240	0.000	0.64	0.00	0.64	0.42	1.53
Column 24	End	ss	-523.240	-0.000	0.64	0.00	0.64	0.42	1.53
Column 25	End	rr	-621.980	0.000	0.77	0.00	0.77	0.42	1.82
Column 25	Edge	ss	-621.980	0.000	0.77	0.00	0.77	0.42	1.82
Column 26	Corner	rr	-215.420	-0.000	0.51	0.00	0.51	0.50	1.02
Column 26	Corner	ss	-215.420	-0.000	0.51	0.00	0.51	0.50	1.02

Legend:

CONDITION.....(a)=Program does not check for this column. No result!

S43 – PUNCHING SHEAR REINFORCEMENT

Not reported

S44 – PUNCHING SHEAR STRESS CHECK PARAMETERS

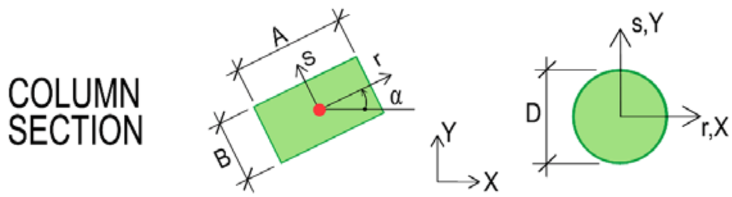


TABLE S44-1 PUNCHING SHEAR DESIGN PARAMETERS

Label	Condition	Axis	Effective depth	Design length rr	Design length ss	Design area	Section constant	Gamma
			mm	mm	mm	mm2	mm4	
Column 7	Corner	rr	305	958	958	5.84E+005	0.00E+000	0.00
Column 7	Corner	ss	305	958	958	5.84E+005	0.00E+000	0.00
Column 8	End	rr	305	1415	958	1.02E+006	0.00E+000	0.00
Column 8	Edge	ss	305	1415	958	1.02E+006	0.00E+000	0.00
Column 9	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 9	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 10	Corner	rr	305	958	958	5.84E+005	0.00E+000	0.00
Column 10	Corner	ss	305	958	958	5.84E+005	0.00E+000	0.00
Column 11	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 11	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 12	Interior	rr	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 12	Interior	ss	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 13	Interior	rr	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 13	Interior	ss	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 14	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 14	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 15	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 15	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 16	Interior	rr	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 16	Interior	ss	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 17	Interior	rr	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 17	Interior	ss	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 18	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 18	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 19	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 19	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 20	Interior	rr	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 20	Interior	ss	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 21	Interior	rr	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 21	Interior	ss	305	1415	1415	1.73E+006	0.00E+000	0.00
Column 22	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 22	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 23	Corner	rr	155	1716	1716	5.32E+005	0.00E+000	0.00
Column 23	Corner	ss	155	1716	1716	5.32E+005	0.00E+000	0.00
Column 24	Edge	rr	305	958	1415	1.02E+006	0.00E+000	0.00
Column 24	End	ss	305	958	1415	1.02E+006	0.00E+000	0.00
Column 25	End	rr	305	1415	958	1.02E+006	0.00E+000	0.00
Column 25	Edge	ss	305	1415	958	1.02E+006	0.00E+000	0.00
Column 26	Corner	rr	155	1716	1716	5.32E+005	0.00E+000	0.00