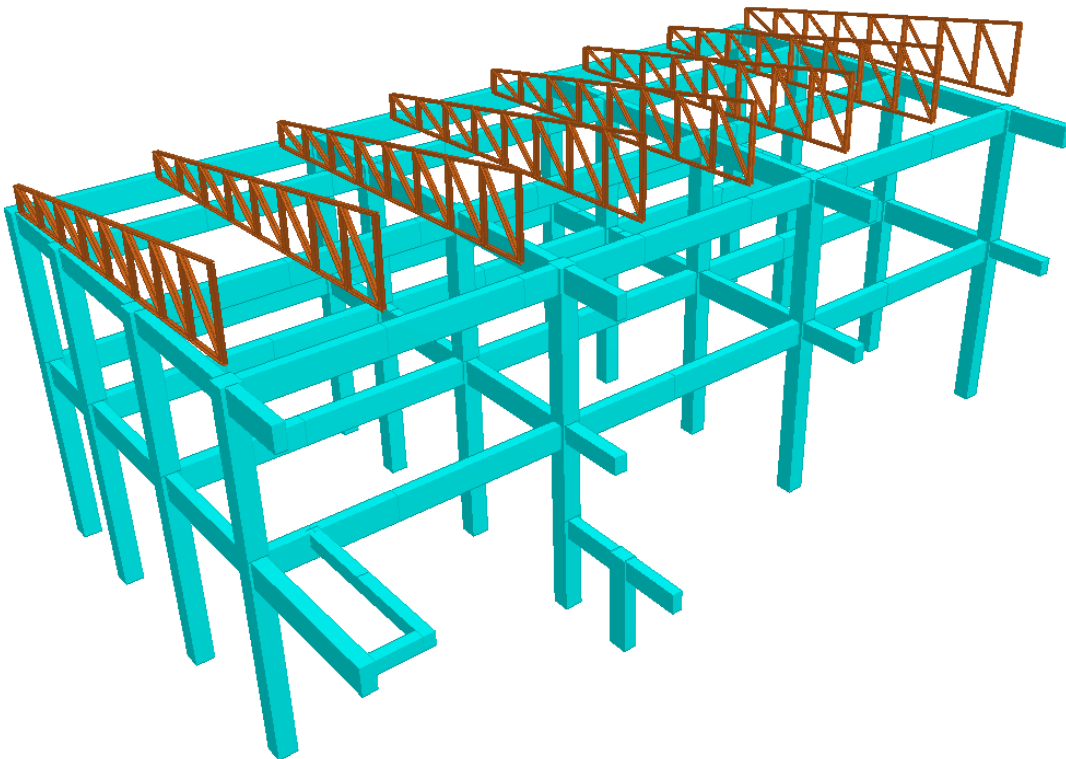


STRUCTURAL ANALYSIS AND DESIGN REPORT

PROPOSED TWO STOREY COMMERCIAL BUILDING



Signed by:

Licensed Civil Engineer



Job Title:

Client:

Engineer:

STAAD SPACE

START JOB INFORMATION

ENGINEER DATE 18-Jan-24

END JOB INFORMATION

SET NL 100

INPUT WIDTH 79

UNIT METER KN

JOINT COORDINATES

17 0 4 0; 18 6 4 0; 19 12 4 0; 20 18 4 0; 21 0 4 2; 22 6 4 2; 23 12 4 2;
24 18 4 2; 25 0 4 5; 26 6 4 5; 27 12 4 5; 28 18 4 5; 29 0 4 8; 30 6 4 8;
31 12 4 8; 32 18 4 8; 33 0 4 11.15; 34 1 4 11.15; 35 1 4 8; 36 6 4 9.5;
37 12 4 9.5; 38 18 4 9.5; 39 1 4 9.5; 40 0 7 0; 41 6 7 0; 42 12 7 0; 43 18 7 0;
44 0 7 2; 45 6 7 2; 46 12 7 2; 47 18 7 2; 48 0 7 5; 49 6 7 5; 50 12 7 5;
51 18 7 5; 52 0 7 8; 53 6 7 8; 54 12 7 8; 55 18 7 8; 56 0 7 9.5; 57 6 7 9.5;
58 12 7 9.5; 59 18 7 9.5; 60 6 2 8; 61 6 2 11.15; 63 6 2 9.575; 64 2.5 4 2;
65 8.5 4 2; 66 14.5 4 2; 67 2.5 4 5; 68 8.5 4 5; 69 14.5 4 5; 70 2.5 4 8;
71 8.5 4 8; 72 14.5 4 8; 73 6 4 1; 74 12 4 1; 75 18 4 1; 76 6 4 2.5;
77 12 4 2.5; 78 18 4 2.5; 79 3.5 4 1; 80 9.5 4 1; 81 15.5 4 1; 82 3.5 4 2.5;
83 9.5 4 2.5; 84 15.5 4 2.5; 85 3.5 4 2; 86 9.5 4 2; 87 15.5 4 2; 88 2.571 7 2;
89 2.571 7 5; 90 2.571 7 8; 91 5.142 7 2; 92 5.142 7 5; 93 5.142 7 8;
94 7.713 7 2; 95 7.713 7 5; 96 7.713 7 8; 97 10.284 7 2; 98 10.284 7 5;
99 10.284 7 8; 100 12.855 7 2; 101 12.855 7 5; 102 12.855 7 8; 103 15.426 7 2;
104 15.426 7 5; 105 15.426 7 8; 1001 0 0 0; 1002 0 0 2; 1003 0 0 5; 1004 0 0 8;
1005 6 0 0; 1006 6 0 2; 1007 6 0 5; 1008 6 0 8; 1009 6 0 9.575; 1010 12 0 0;
1011 12 0 2; 1012 12 0 5; 1013 12 0 8; 1014 18 0 0; 1015 18 0 2; 1016 18 0 5;
1017 18 0 8;

MEMBER INCIDENCES

73 39 36; 74 36 37; 75 37 38; 120 56 57; 121 57 58; 122 58 59; 136 64 67;
137 65 68; 138 66 69; 139 67 70; 140 68 71; 141 69 72; 148 73 79; 149 74 80;
150 75 81; 151 76 82; 152 77 83; 153 78 84; 154 79 85; 155 80 86; 156 81 87;
160 85 82; 161 86 83; 162 87 84; 1101 1001 17; 1102 1002 21; 1103 1003 25;
1104 1004 29; 1105 1005 18; 1106 1006 22; 1107 1007 26; 1108 1008 60;
1109 60 30; 1110 1009 63; 1111 1010 19; 1112 1011 23; 1113 1012 27;
1114 1013 31; 1115 1014 20; 1116 1015 24; 1117 1016 28; 1118 1017 32;
2101 17 40; 2102 21 44; 2103 25 48; 2104 29 52; 2105 18 41; 2106 22 45;
2107 26 49; 2108 30 53; 2109 19 42; 2110 23 46; 2111 27 50; 2112 31 54;
2113 20 43; 2114 24 47; 2115 28 51; 2116 32 55; 12101 17 18; 12102 18 19;
12103 19 20; 12104 21 64; 12105 64 85; 12106 85 22; 12107 22 65; 12108 65 86;
12109 86 23; 12110 23 66; 12111 66 87; 12112 87 24; 12113 25 67; 12114 67 26;
12115 26 68; 12116 68 27; 12117 27 69; 12118 69 28; 12119 29 35; 12120 35 70;
12121 70 30; 12122 30 71; 12123 71 31; 12124 31 72; 12125 72 32; 12126 33 34;
12127 17 21; 12128 21 25; 12129 25 29; 12130 29 33; 12131 35 39; 12132 39 34;
12133 18 73; 12134 73 22; 12135 22 76; 12136 76 26; 12137 26 30; 12138 30 36;
12139 60 63; 12140 63 61; 12141 19 74; 12142 74 23; 12143 23 77; 12144 77 27;
12145 27 31; 12146 31 37; 12147 20 75; 12148 75 24; 12149 24 78; 12150 78 28;



Job Title:

Client:

Engineer:

12151 28 32; 12152 32 38; 22101 40 41; 22102 41 42; 22103 42 43; 22104 44 88;
22105 88 91; 22106 91 45; 22107 45 94; 22108 94 97; 22109 97 46; 22110 46 100;
22111 100 103; 22112 103 47; 22113 48 89; 22114 89 92; 22115 92 49;
22116 49 95; 22117 95 98; 22118 98 50; 22119 50 101; 22120 101 104;
22121 104 51; 22122 52 90; 22123 90 93; 22124 93 53; 22125 53 96; 22126 96 99;
22127 99 54; 22128 54 102; 22129 102 105; 22130 105 55; 22131 40 44;
22132 44 48; 22133 48 52; 22134 52 56; 22135 41 45; 22136 45 49; 22137 49 53;
22138 53 57; 22139 42 46; 22140 46 50; 22141 50 54; 22142 54 58; 22143 43 47;
22144 47 51; 22145 51 55; 22146 55 59;

START GROUP DEFINITION

FLOOR

_2F_1WAYCEILSLAB 73 TO 75 12101 TO 12112 12119 TO 12127 12130 TO 12134 12138 -
12141 12142 12146 TO 12148 12152

_2F_2WAYCEILSLAB 12104 TO 12125 12128 12129 12135 TO 12137 12143 TO 12145 -
12149 TO 12151

_RF_1WAYCEIL 22101 TO 22112 22131 22135 22139 22143

_RF_2WAYCEIL 22104 TO 22130 22132 22133 22136 22137 22140 22141 22144 22145

_RF_1WAYSLABCEIL 120 TO 122 22122 TO 22130 22134 22138 22142 22146

_2F_2WAYBFA 12104 TO 12125 12128 12129 12135 TO 12137 12143 TO 12145 12149 -
12150 TO 12151

_2F_1WAYBALC 12101 TO 12112 12127 12133 12134 12141 12142 12147 12148

_2F_1WAYCORR 73 TO 75 12119 TO 12126 12130 TO 12132 12138 12146 12152

MEMBER

_W1 136 TO 141 148 TO 156 160 TO 162 12104 12105 12107 12108 12110 12111 -
12113 12115 12117 12119 TO 12125 12127 TO 12129 12133 TO 12137 -
12141 TO 12145 12147 TO 12151

_RAILINGS 73 TO 75 12101 TO 12103 12126 12130 12152

_W2 120 TO 122 22101 TO 22103 22131 TO 22134 22143 TO 22146

_SHADE 12126 12130

_STAIRS 12132 12139 12140

_STAIRS_RIGHT 12139 12140

JOINT

_101 44 47 88 91 94 97 100 103

_102 48 51 89 92 95 98 101 104

_103 52 55 90 93 96 99 102 105

END GROUP DEFINITION

DEFINE MATERIAL START

ISOTROPIC CONCRETE_21MPA

E 2.15381e+07

POISSON 0.17

DENSITY 23.56

ALPHA 1e-05

DAMP 0.05

G 9.28139e+06

TYPE CONCRETE



Job Title:

Client:

Engineer:

```
STRENGTH FCU 21000
ISOTROPIC DUMMY
E 200000
G 70000
ISOTROPIC CONCRETE
E 2.17185e+07
POISSON 0.17
DENSITY 23.5616
ALPHA 1e-05
DAMP 0.05
G 9.28139e+06
TYPE CONCRETE
STRENGTH FCU 27579
END DEFINE MATERIAL
MEMBER PROPERTY
1104 1106 TO 1109 1112 TO 1114 1118 PRIS YD 0.35 ZD 0.35
2104 2106 TO 2108 2110 TO 2112 2116 PRIS YD 0.35 ZD 0.35
1101 TO 1103 1105 1111 1115 TO 1117 PRIS YD 0.35 ZD 0.35
2101 TO 2103 2105 2109 2113 TO 2115 PRIS YD 0.35 ZD 0.35
1110 PRIS YD 0.4 ZD 0.25
12104 TO 12118 PRIS YD 0.5 ZD 0.25
12129 12135 TO 12137 12143 TO 12145 12151 PRIS YD 0.5 ZD 0.2
12127 12128 12133 12134 12141 12142 12147 TO 12150 PRIS YD 0.5 ZD 0.2
12101 TO 12103 12119 TO 12125 PRIS YD 0.5 ZD 0.2
22104 TO 22121 PRIS YD 0.45 ZD 0.2
22101 TO 22103 22122 TO 22130 PRIS YD 0.5 ZD 0.2
22131 TO 22133 22143 TO 22145 PRIS YD 0.4 ZD 0.2
22135 TO 22137 22139 TO 22141 PRIS YD 0.45 ZD 0.2
12130 PRIS YD 0.5 ZD 0.25
12138 12146 12152 PRIS YD 0.35 ZD 0.25
22134 22138 22142 22146 PRIS YD 0.45 ZD 0.2
12126 12131 12132 PRIS YD 0.25 ZD 0.2
73 TO 75 120 TO 122 136 TO 141 148 TO 156 160 TO 162 PRIS YD 0.1
12139 12140 PRIS YD 0.4 ZD 0.2
CONSTANTS
BETA 90 MEMB 1110
MATERIAL CONCRETE_21MPA MEMB 1101 TO 1118 2101 TO 2116 12101 TO 12152 22101 -
22102 TO 22146
MATERIAL DUMMY MEMB 73 TO 75 120 TO 122 136 TO 141 148 TO 156 160 TO 162
MEMBER CRACKED
1101 TO 1118 2101 TO 2116 REDUCTION RIY 0.7 RIZ 0.7
12101 TO 12152 22101 TO 22146 REDUCTION RIY 0.35 RIZ 0.35
MEMBER RELEASE
12131 START MZ
12130 12132 END MZ
```



Job Title:

Client:

Engineer:

SUPPORTS

1001 TO 1017 FIXED

MEMBER OFFSET

12105 12106 12108 12109 12111 12112 12114 12116 12118 12120 12121 12123 -
12125 12134 12136 12142 12144 12148 12150 22123 22124 22126 22127 22129 -
22130 START 0 -0.25 0
12104 12105 12107 12108 12110 12111 12113 12115 12117 12119 12120 12122 -
12124 12133 12135 12141 12143 12147 12149 22122 22123 22125 22126 22128 -
22129 END 0 -0.25 0
22105 22106 22108 22109 22111 22112 22114 22115 22117 22118 22120 -
22121 START 0 -0.225 0
22104 22105 22107 22108 22110 22111 22113 22114 22116 22117 22119 22120 -
22134 22138 22142 22146 END 0 -0.225 0
12138 12146 12152 START 0 -0.175 0.175
12138 12146 12152 END 0 -0.175 0
12131 12132 START 0 -0.125 0
12131 END 0 -0.125 0
12101 TO 12104 12107 12110 12113 12115 12117 12119 12122 12124 -
22101 TO 22103 22122 22125 22128 START 0.175 -0.25 0
12101 TO 12103 12106 12109 12112 12114 12116 12118 12121 12123 12125 22101 -
22102 TO 22103 22124 22127 22130 END -0.175 -0.25 0
12127 TO 12130 12133 12135 12137 12141 12143 12145 12147 12149 -
12151 START 0 -0.25 0.175
12127 TO 12129 12134 12136 12137 12142 12144 12145 12148 12150 -
12151 END 0 -0.25 -0.175
22104 22107 22110 22113 22116 22119 START 0.175 -0.225 0
22106 22109 22112 22115 22118 22121 END -0.175 -0.225 0
22134 TO 22142 22146 START 0 -0.225 0.175
22135 TO 22137 22139 TO 22141 END 0 -0.225 -0.175
12139 12140 22131 TO 22133 22143 TO 22145 START 0 -0.2 0.175
12139 12140 22131 TO 22133 22143 TO 22145 END 0 -0.2 -0.175
12126 START 0.125 -0.125 0
12126 END -0.1 -0.125 0
12130 END 0 -0.25 0.1
12132 END 0 -0.125 0.1
DEFINE REFERENCE LOADS
LOAD R1 LOADTYPE Dead TITLE DL
SELFWEIGHT Y -1
FLOOR LOAD
_2F_2WAYCEILSLAB FLOAD -4.6 GY
ONEWAY LOAD
_2F_1WAYCEILSLAB ONE -4 GY
_RF_1WAYCEIL ONE -0.8 GY
FLOOR LOAD
_RF_2WAYCEIL FLOAD -0.8 GY



Job Title:

Client:

Engineer:

```
ONEWAY LOAD
_RF_1WAYSLABCEIL ONE -4 GY
MEMBER LOAD
_W1 UNI GY -9.5
_W2 UNI GY -6.55
_RAILINGS UNI GY -2
_STAIRS UNI GY -18.91
_STAIRS_RIGHT UNI GY -3
_SHADE UNI GY -2.3
JOINT LOAD
63 FY -4
_101 FX 0 FY -3.137 FZ 0.849 MX 0 MY 0 MZ 0
_102 FX 0 FY -2.349 FZ -0.974 MX 0 MY 0 MZ 0
_103 FX 0 FY -1.093 FZ 0.125 MX 0 MY 0 MZ 0
MEMBER LOAD
12130 UNI GY -3
120 UNI GY -4.3
120 UMOM X 3.53
12106 22131 TO 22134 UNI GY -2.6
12106 22131 TO 22134 UMOM X 1.3
JOINT LOAD
39 FY -2
34 61 FY -6.12
LOAD R2 LOADTYPE Live TITLE LL
FLOOR LOAD
_2F_2WAYBFA FLOAD -2.5 GY
_2F_1WAYBALC FLOAD -2.9 GY
ONEWAY LOAD
_2F_1WAYCORR ONE -4.8 GY
MEMBER LOAD
_STAIRS UNI GY -14.9
12130 12139 12140 UNI GY -4.8
JOINT LOAD
_101 FX 0 FY -9.926 FZ 2.644 MX 0 MY 0 MZ 0
_102 FX 0 FY -7.2 FZ -3.041 MX 0 MY 0 MZ 0
_103 FX 0 FY -3.163 FZ 0.397 MX 0 MY 0 MZ 0
END DEFINE REFERENCE LOADS
FLOOR DIAPHRAGM
DIA 1 TYPE RIG HEI 4 JOINT 17 TO 39 64 TO 87
CHECK SOFT STORY ASCE7
DEFINE UBC LOAD
ZONE 0.4 I 1 RWX 5.5 RWZ 5.5 STYP 4 NA 1 NV 1
REFERENCE LOAD Y
R1 1.0 R2 0.25
DEFINE WIND LOAD
```



Job Title:

Client:

Engineer:

```
TYPE 1 WWX
<! STAAD PRO GENERATED DATA DO NOT MODIFY !!!
ASCE-7-2010:PARAMS 260.000 KMPH 0 1 1 0 0.000 FT 0.000 FT 0.000 FT 1 2 9.100 -
M 18.000 M 11.000 M 2.000 0.010 0 0 0 0 0.700 1.000 1.000 0.850 0 0 0 0 -
0.865 0.800 -0.180
!> END GENERATED DATA BLOCK
INT 1.424 1.424 1.447 1.469 1.49 1.51 1.529 1.547 1.565 1.582 1.598 1.614 -
1.63 1.645 1.66 HEIG 0 4.572 4.92 5.269 5.617 5.965 6.314 6.662 7.01 7.358 -
7.707 8.055 8.403 8.752 9.1
TYPE 2 LWX
<! STAAD PRO GENERATED DATA DO NOT MODIFY !!!
ASCE-7-2010:PARAMS 260.000 KMPH 0 1 1 0 0.000 FT 0.000 FT 0.000 FT 1 2 9.100 -
M 18.000 M 11.000 M 2.000 0.010 1 0 0 0 0.700 1.000 1.000 0.850 0 0 0 0 -
0.865 -0.373 0.180
!> END GENERATED DATA BLOCK
INT -0.956102 -0.956102 HEIG 0 9.1
TYPE 3 WWZ
<! STAAD PRO GENERATED DATA DO NOT MODIFY !!!
ASCE-7-2010:PARAMS 260.000 KMPH 0 1 1 0 0.000 FT 0.000 FT 0.000 FT 1 2 9.100 -
M 11.000 M 18.000 M 2.000 0.010 0 0 0 0 0.700 1.000 1.000 0.850 0 0 0 0 -
0.855 0.800 -0.180
!> END GENERATED DATA BLOCK
INT 1.412 1.412 1.434 1.456 1.476 1.496 1.515 1.533 1.55 1.567 1.584 1.599 -
1.615 1.63 1.644 HEIG 0 4.572 4.92 5.269 5.617 5.965 6.314 6.662 7.01 7.358 -
7.707 8.055 8.403 8.752 9.1
TYPE 4 LWZ
<! STAAD PRO GENERATED DATA DO NOT MODIFY !!!
ASCE-7-2010:PARAMS 260.000 KMPH 0 1 1 0 0.000 FT 0.000 FT 0.000 FT 1 2 9.100 -
M 11.000 M 18.000 M 2.000 0.010 1 0 0 0 0.700 1.000 1.000 0.850 0 0 0 0 -
0.855 -0.500 0.180
!> END GENERATED DATA BLOCK
INT -1.15589 -1.15589 HEIG 0 9.1
LOAD 1 LOADTYPE Seismic-H TITLE EQ +X +E
UBC LOAD X 1 DEC 1 ACC 0.05
PERFORM ANALYSIS
CHANGE
LOAD 2 LOADTYPE Seismic-H TITLE EQ +X -E
UBC LOAD X 1 DEC 1 ACC -0.05
PERFORM ANALYSIS
CHANGE
LOAD 3 LOADTYPE Seismic-H TITLE EQ -X +E
UBC LOAD X -1 DEC 1 ACC 0.05
PERFORM ANALYSIS
CHANGE
LOAD 4 LOADTYPE Seismic-H TITLE EQ -X -E
```



Job Title:

Client:

Engineer:

```
UBC LOAD X -1 DEC 1 ACC -0.05
PERFORM ANALYSIS
CHANGE
LOAD 5 LOADTYPE Seismic-H TITLE EQ +Z +E
UBC LOAD Z 1 DEC 1 ACC 0.05
PERFORM ANALYSIS
CHANGE
LOAD 6 LOADTYPE Seismic-H TITLE EQ +Z -E
UBC LOAD Z 1 DEC 1 ACC -0.05
PERFORM ANALYSIS
CHANGE
LOAD 7 LOADTYPE Seismic-H TITLE EQ -Z +E
UBC LOAD Z -1 DEC 1 ACC 0.05
PERFORM ANALYSIS
CHANGE
LOAD 8 LOADTYPE Seismic-H TITLE EQ -Z -E
UBC LOAD Z -1 DEC 1 ACC -0.05
PERFORM ANALYSIS
CHANGE
LOAD 9 LOADTYPE Dead TITLE DL
REFERENCE LOAD
R1 1.0
LOAD 10 LOADTYPE Live TITLE LL
REFERENCE LOAD
R2 1.0
LOAD 11 LOADTYPE Wind TITLE WL +X
WIND LOAD X 1 TYPE 1 ZR 0 8
WIND LOAD -X 1 TYPE 2 ZR 0 8
LOAD 12 LOADTYPE Wind TITLE WL -X
WIND LOAD X -1 TYPE 1 ZR 0 8
WIND LOAD -X -1 TYPE 2 ZR 0 8
LOAD 13 LOADTYPE Wind TITLE WL +Z
WIND LOAD Z 1 TYPE 3
WIND LOAD -Z 1 TYPE 4 XR 0 6
WIND LOAD -Z 1 TYPE 4 XR 6 18 YR 4 7
LOAD 14 LOADTYPE Wind TITLE WL -Z
WIND LOAD Z -1 TYPE 3 XR 0 6
WIND LOAD Z -1 TYPE 3 XR 6 18 YR 4 7
WIND LOAD -Z -1 TYPE 4
LOAD 101 GENERATED NSCP 2015 DRIFT CHECK 1
REPEAT LOAD
9 1.2 11 0.5
LOAD 102 GENERATED NSCP 2015 DRIFT CHECK 2
REPEAT LOAD
9 1.2 12 0.5
```



Job Title:

Client:

Engineer:

LOAD 103 GENERATED NSCP 2015 DRIFT CHECK 3
REPEAT LOAD
9 1.2 13 0.5
LOAD 104 GENERATED NSCP 2015 DRIFT CHECK 4
REPEAT LOAD
9 1.2 14 0.5
LOAD 105 GENERATED NSCP 2015 DRIFT CHECK 5
REPEAT LOAD
9 1.2 10 0.5 11 1.0
LOAD 106 GENERATED NSCP 2015 DRIFT CHECK 6
REPEAT LOAD
9 1.2 10 0.5 12 1.0
LOAD 107 GENERATED NSCP 2015 DRIFT CHECK 7
REPEAT LOAD
9 1.2 10 0.5 13 1.0
LOAD 108 GENERATED NSCP 2015 DRIFT CHECK 8
REPEAT LOAD
9 1.2 10 0.5 14 1.0
LOAD 109 GENERATED NSCP 2015 DRIFT CHECK 9
REPEAT LOAD
9 1.2 10 0.5 1 1.0
LOAD 110 GENERATED NSCP 2015 DRIFT CHECK 10
REPEAT LOAD
9 1.2 10 0.5 2 1.0
LOAD 111 GENERATED NSCP 2015 DRIFT CHECK 11
REPEAT LOAD
9 1.2 10 0.5 3 1.0
LOAD 112 GENERATED NSCP 2015 DRIFT CHECK 12
REPEAT LOAD
9 1.2 10 0.5 4 1.0
LOAD 113 GENERATED NSCP 2015 DRIFT CHECK 13
REPEAT LOAD
9 1.2 10 0.5 5 1.0
LOAD 114 GENERATED NSCP 2015 DRIFT CHECK 14
REPEAT LOAD
9 1.2 10 0.5 6 1.0
LOAD 115 GENERATED NSCP 2015 DRIFT CHECK 15
REPEAT LOAD
9 1.2 10 0.5 7 1.0
LOAD 116 GENERATED NSCP 2015 DRIFT CHECK 16
REPEAT LOAD
9 1.2 10 0.5 8 1.0
LOAD 117 GENERATED NSCP 2015 DRIFT CHECK 17
REPEAT LOAD
9 0.9 11 1.0



Job Title:

Client:

Engineer:

LOAD 118 GENERATED NSCP 2015 DRIFT CHECK 18
REPEAT LOAD
9 0.9 12 1.0
LOAD 119 GENERATED NSCP 2015 DRIFT CHECK 19
REPEAT LOAD
9 0.9 13 1.0
LOAD 120 GENERATED NSCP 2015 DRIFT CHECK 20
REPEAT LOAD
9 0.9 14 1.0
LOAD 121 GENERATED NSCP 2015 DRIFT CHECK 21
REPEAT LOAD
9 0.9 1 1.0
LOAD 122 GENERATED NSCP 2015 DRIFT CHECK 22
REPEAT LOAD
9 0.9 2 1.0
LOAD 123 GENERATED NSCP 2015 DRIFT CHECK 23
REPEAT LOAD
9 0.9 3 1.0
LOAD 124 GENERATED NSCP 2015 DRIFT CHECK 24
REPEAT LOAD
9 0.9 4 1.0
LOAD 125 GENERATED NSCP 2015 DRIFT CHECK 25
REPEAT LOAD
9 0.9 5 1.0
LOAD 126 GENERATED NSCP 2015 DRIFT CHECK 26
REPEAT LOAD
9 0.9 6 1.0
LOAD 127 GENERATED NSCP 2015 DRIFT CHECK 27
REPEAT LOAD
9 0.9 7 1.0
LOAD 128 GENERATED NSCP 2015 DRIFT CHECK 28
REPEAT LOAD
9 0.9 8 1.0
LOAD 201 Generated NSCP 2015 USD/LRFD + Ev Comb. 1
REPEAT LOAD
9 1.4
LOAD 202 Generated NSCP 2015 USD/LRFD + Ev Comb. 2
REPEAT LOAD
9 1.2 10 1.6
LOAD 203 Generated NSCP 2015 USD/LRFD + Ev Comb. 3
REPEAT LOAD
9 1.2 10 0.5
LOAD 204 Generated NSCP 2015 USD/LRFD + Ev Comb. 4
REPEAT LOAD
9 1.2 11 0.5



Job Title:

Client:

Engineer:

LOAD 205 Generated NSCP 2015 USD/LRFD + Ev Comb. 5
REPEAT LOAD
9 1.2 12 0.5
LOAD 206 Generated NSCP 2015 USD/LRFD + Ev Comb. 6
REPEAT LOAD
9 1.2 13 0.5
LOAD 207 Generated NSCP 2015 USD/LRFD + Ev Comb. 7
REPEAT LOAD
9 1.2 14 0.5
LOAD 208 Generated NSCP 2015 USD/LRFD + Ev Comb. 8
REPEAT LOAD
9 1.2 10 0.5 11 1.0
LOAD 209 Generated NSCP 2015 USD/LRFD + Ev Comb. 9
REPEAT LOAD
9 1.2 10 0.5 12 1.0
LOAD 210 Generated NSCP 2015 USD/LRFD + Ev Comb. 10
REPEAT LOAD
9 1.2 10 0.5 13 1.0
LOAD 211 Generated NSCP 2015 USD/LRFD + Ev Comb. 11
REPEAT LOAD
9 1.2 10 0.5 14 1.0
LOAD 212 Generated NSCP 2015 USD/LRFD + Ev Comb. 12
REPEAT LOAD
9 0.9 11 1.0
LOAD 213 Generated NSCP 2015 USD/LRFD + Ev Comb. 13
REPEAT LOAD
9 0.9 12 1.0
LOAD 214 Generated NSCP 2015 USD/LRFD + Ev Comb. 14
REPEAT LOAD
9 0.9 13 1.0
LOAD 215 Generated NSCP 2015 USD/LRFD + Ev Comb. 15
REPEAT LOAD
9 0.9 14 1.0
LOAD 216 Generated NSCP 2015 USD/LRFD + Ev Comb. 16
REPEAT LOAD
9 1.42 10 0.5 1 1.0
LOAD 217 Generated NSCP 2015 USD/LRFD + Ev Comb. 17
REPEAT LOAD
9 1.42 10 0.5 2 1.0
LOAD 218 Generated NSCP 2015 USD/LRFD + Ev Comb. 18
REPEAT LOAD
9 1.42 10 0.5 3 1.0
LOAD 219 Generated NSCP 2015 USD/LRFD + Ev Comb. 19
REPEAT LOAD
9 1.42 10 0.5 4 1.0



Job Title:

Client:

Engineer:

LOAD 220 Generated NSCP 2015 USD/LRFD + Ev Comb. 20
REPEAT LOAD
9 1.42 10 0.5 5 1.0
LOAD 221 Generated NSCP 2015 USD/LRFD + Ev Comb. 21
REPEAT LOAD
9 1.42 10 0.5 6 1.0
LOAD 222 Generated NSCP 2015 USD/LRFD + Ev Comb. 22
REPEAT LOAD
9 1.42 10 0.5 7 1.0
LOAD 223 Generated NSCP 2015 USD/LRFD + Ev Comb. 23
REPEAT LOAD
9 1.42 10 0.5 8 1.0
LOAD 224 Generated NSCP 2015 USD/LRFD + Ev Comb. 24
REPEAT LOAD
9 1.12 1 1.0
LOAD 225 Generated NSCP 2015 USD/LRFD + Ev Comb. 25
REPEAT LOAD
9 1.12 2 1.0
LOAD 226 Generated NSCP 2015 USD/LRFD + Ev Comb. 26
REPEAT LOAD
9 1.12 3 1.0
LOAD 227 Generated NSCP 2015 USD/LRFD + Ev Comb. 27
REPEAT LOAD
9 1.12 4 1.0
LOAD 228 Generated NSCP 2015 USD/LRFD + Ev Comb. 28
REPEAT LOAD
9 1.12 5 1.0
LOAD 229 Generated NSCP 2015 USD/LRFD + Ev Comb. 29
REPEAT LOAD
9 1.12 6 1.0
LOAD 230 Generated NSCP 2015 USD/LRFD + Ev Comb. 30
REPEAT LOAD
9 1.12 7 1.0
LOAD 231 Generated NSCP 2015 USD/LRFD + Ev Comb. 31
REPEAT LOAD
9 1.12 8 1.0
LOAD 232 Generated NSCP 2015 USD/LRFD + Ev Comb. 32
REPEAT LOAD
9 0.68 1 1.0
LOAD 233 Generated NSCP 2015 USD/LRFD + Ev Comb. 33
REPEAT LOAD
9 0.68 2 1.0
LOAD 234 Generated NSCP 2015 USD/LRFD + Ev Comb. 34
REPEAT LOAD
9 0.68 3 1.0



Job Title:

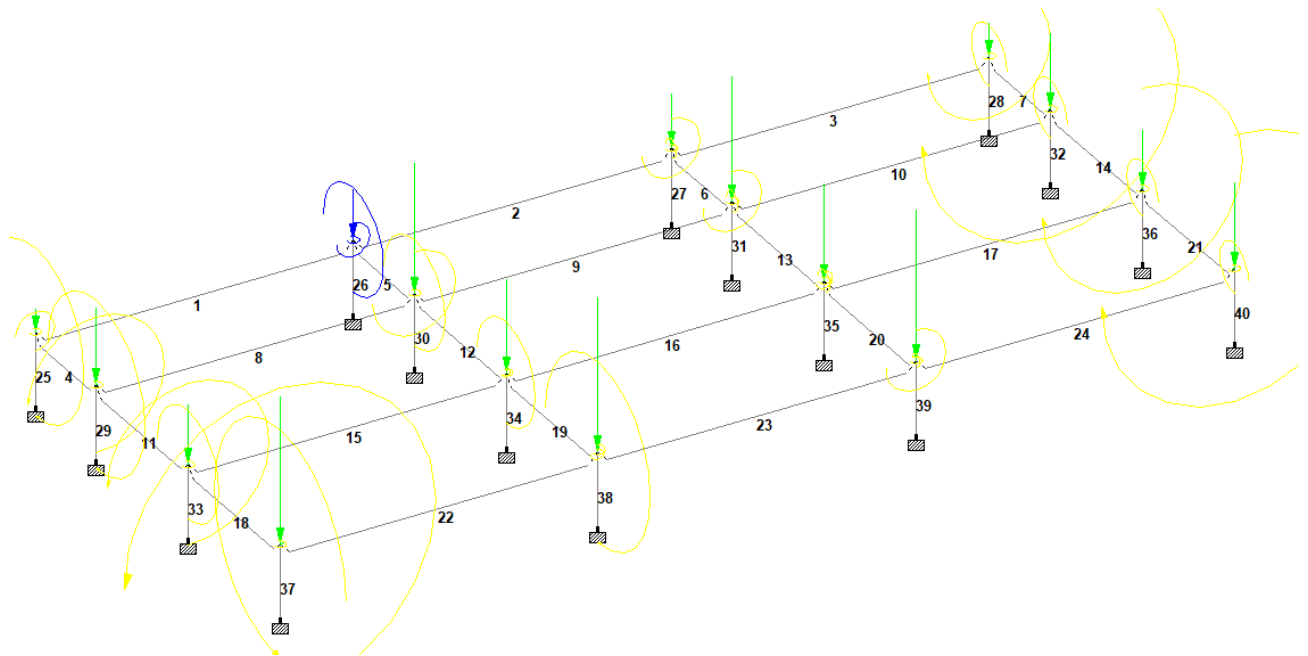
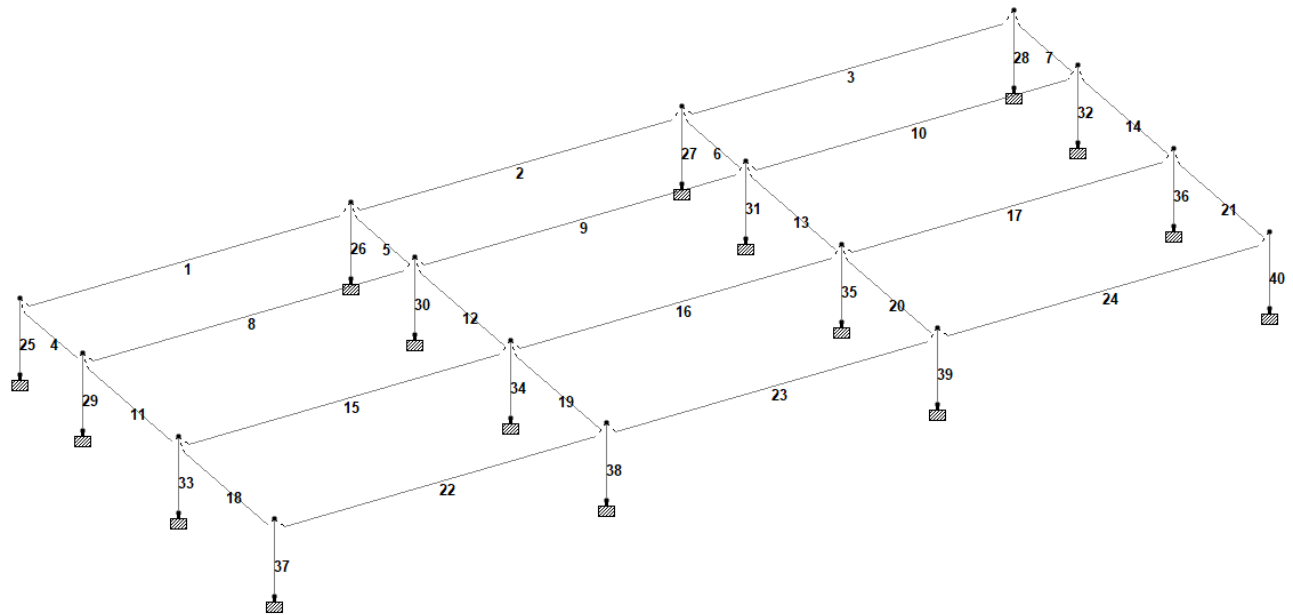
Client:

Engineer:

LOAD 235 Generated NSCP 2015 USD/LRFD + Ev Comb. 35
REPEAT LOAD
9 0.68 4 1.0
LOAD 236 Generated NSCP 2015 USD/LRFD + Ev Comb. 36
REPEAT LOAD
9 0.68 5 1.0
LOAD 237 Generated NSCP 2015 USD/LRFD + Ev Comb. 37
REPEAT LOAD
9 0.68 6 1.0
LOAD 238 Generated NSCP 2015 USD/LRFD + Ev Comb. 38
REPEAT LOAD
9 0.68 7 1.0
LOAD 239 Generated NSCP 2015 USD/LRFD + Ev Comb. 39
REPEAT LOAD
9 0.68 8 1.0
PDELTA 20 ANALYSIS
LOAD LIST 101 TO 128
PRINT STORY DRIFT 0.006500
FINISH

Note: Beams without number in the second image are dummy members. They are used to transmit forces such as walls, floors, and roofing to structural sections.

SUBSTRUCTURE MODEL



SOFT STORY

PROPOSED TWO STOREY COMMERCIAL BUILDING

FLOOR DIAPHRAGM

```
*****
FLOOR DIAPHRAGM      UNIT - KN  METE
-----
NO.  TYPE      FL. LEVEL  FL. WT  CENTRE  OF  MASS  CONTROL JOINT NO.
          X      Z
1  RIGID      4.000      2745.60  8.552   4.789      1018
*****
```

PROBLEM STATISTICS

```
NUMBER OF JOINTS      106  NUMBER OF MEMBERS      156
NUMBER OF PLATES      0   NUMBER OF SOLIDS        0
NUMBER OF SURFACES     0   NUMBER OF SUPPORTS      17
```

Using 64-bit analysis engine.

SOLVER USED IS THE IN-CORE ADVANCED MATH SOLVER

TOTAL PRIMARY LOAD CASES = 1, TOTAL DEGREES OF FREEDOM = 393

SOFT STORY CHECK

VERTICAL STRUCTURAL IRREGULARITIES : SOFT STORY CHECK - ASCE/SEI 7-05

```
STORY      FL. LEVEL IN METE      S T A T U S
-----
1          4.00      OK          OK
```

NOTE : NO SOFT STOREY IS DETECTED.

```
*****
*
* X DIRECTION : Ta = 0.315 Tb = 0.592 Tuser = 0.000 *
* T = 0.315, LOAD FACTOR = 1.000 *
* UBC TYPE = 97 *
* UBC FACTOR V = 0.2000 x 3512.71 = 702.54 KN *
*
*****
```

LOAD NO.: 1 DIRECTION : X UNIT - METE

```
STORY  LEVEL  DYN. ECC. (dec)  ACC. ECC. (aec)  DESIGN ECC.
-----
          X      Z      X      Z      X      Z
          dec + aec dec + aec
1      4.00      0.00      0.00      0.90      0.56      0.00      0.56
```

STORY DRIFT

PROPOSED TWO STOREY COMMERCIAL BUILDING

513. LOAD LIST 101 TO 128
 514. PRINT STORY DRIFT 0.006500
 STORY DRIFT 0.006500

STORY	HEIGHT	LOAD	AVG. DISP(CM)		DRIFT(CM)		RATIO	STATUS
(METER)			X	Z	X	Z		
BASE=	0.00						ALLOW. DRIFT = L / 154	
1	0.00	101	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		102	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		103	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		104	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		105	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		106	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		107	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		108	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		109	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		110	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		111	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		112	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		113	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		114	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		115	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		116	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS
		117	0.0000	0.0000	0.0000	0.0000	L / 999999	PASS

STAAD SPACE

-- PAGE NO. 21

		118	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		119	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		120	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		121	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		122	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		123	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		124	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		125	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		126	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		127	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
		128	0.0000	0.0000	0.0000	0.0000 L / 999999	PASS
2	4.00	101	0.1827	0.0792	0.1827	0.0792 L / 2190	PASS
		102	-0.0325	0.0791	0.0325	0.0791 L / 5054	PASS
		103	0.0752	0.2774	0.0752	0.2774 L / 1442	PASS
		104	0.0736	-0.1008	0.0736	0.1008 L / 3967	PASS
		105	0.3029	0.1018	0.3029	0.1018 L / 1320	PASS
		106	-0.1285	0.1016	0.1285	0.1016 L / 3114	PASS
		107	0.0875	0.4989	0.0875	0.4989 L / 802	PASS
		108	0.0843	-0.2590	0.0843	0.2590 L / 1544	PASS
		109	1.6987	0.1086	1.6987	0.1086 L / 235	PASS
		110	1.6837	0.1050	1.6837	0.1050 L / 237	PASS
		111	-1.5264	0.0941	1.5264	0.0941 L / 262	PASS
		112	-1.5113	0.0980	1.5113	0.0980 L / 264	PASS
		113	0.1034	1.4567	0.1034	1.4567 L / 274	PASS
		114	0.0787	1.4507	0.0787	1.4507 L / 276	PASS
		115	0.0695	-1.2532	0.0695	1.2532 L / 319	PASS
		116	0.0935	-1.2471	0.0935	1.2471 L / 321	PASS
		117	0.2704	0.0585	0.2704	0.0585 L / 1479	PASS

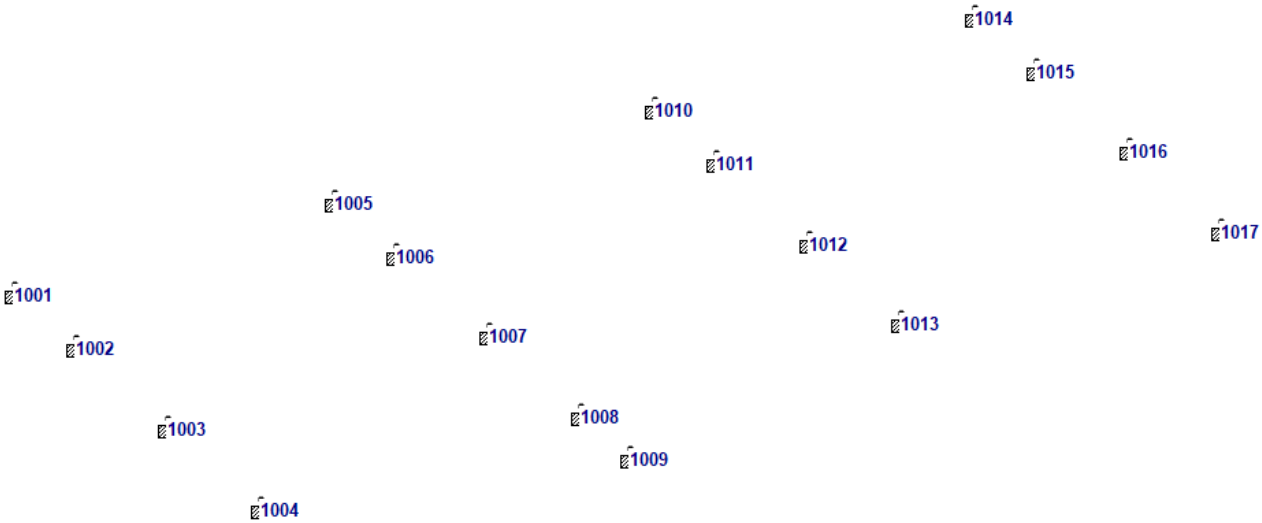
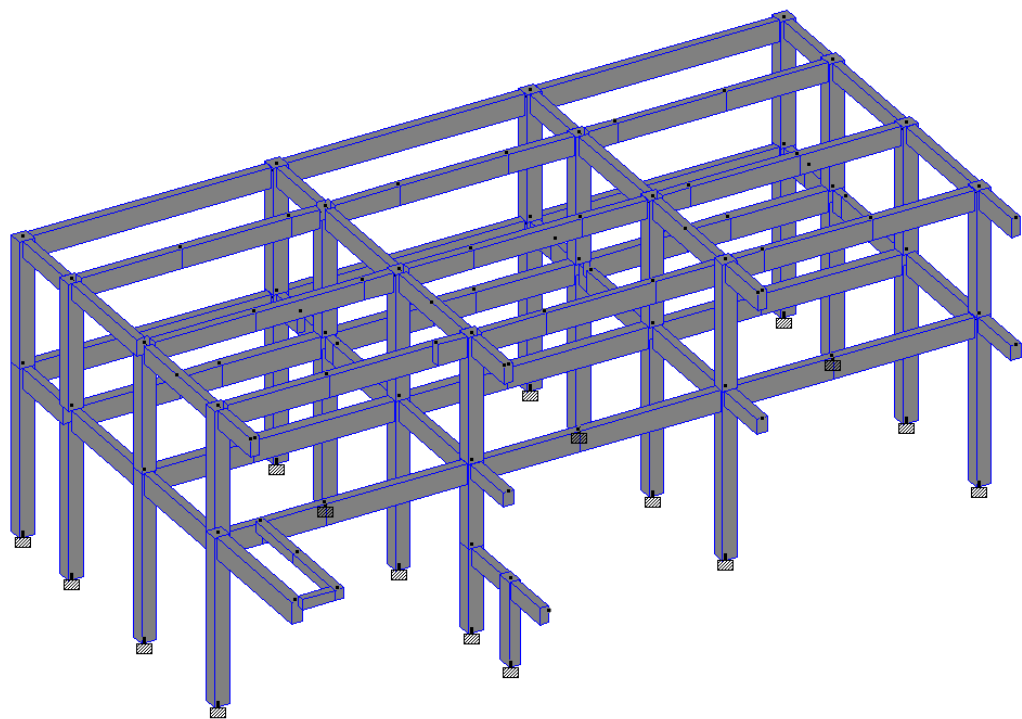
STORY DRIFT

PROPOSED TWO STOREY COMMERCIAL BUILDING

STORY	HEIGHT	LOAD	AVG. DISP(CM)		DRIFT(CM)		RATIO	STATUS
(METER)			X	Z	X	Z		
BASE=	0.00						ALLOW. DRIFT = L / 154	
		118	-0.1574	0.0584	0.1574	0.0584	L / 2541	PASS
		119	0.0568	0.4527	0.0568	0.4527	L / 883	PASS
		120	0.0536	-0.2997	0.0536	0.2997	L / 1335	PASS
		121	1.6546	0.0652	1.6546	0.0652	L / 242	PASS
		122	1.6398	0.0617	1.6398	0.0617	L / 244	PASS
		123	-1.5436	0.0510	1.5436	0.0510	L / 259	PASS
		124	-1.5288	0.0548	1.5288	0.0548	L / 261	PASS
		125	0.0723	1.4036	0.0723	1.4036	L / 285	PASS
		126	0.0480	1.3976	0.0480	1.3976	L / 286	PASS
		127	0.0392	-1.2865	0.0392	1.2865	L / 311	PASS
		128	0.0628	-1.2806	0.0628	1.2806	L / 312	PASS

SUPPORT REACTIONS

PROPOSED TWO STOREY COMMERCIAL BUILDING



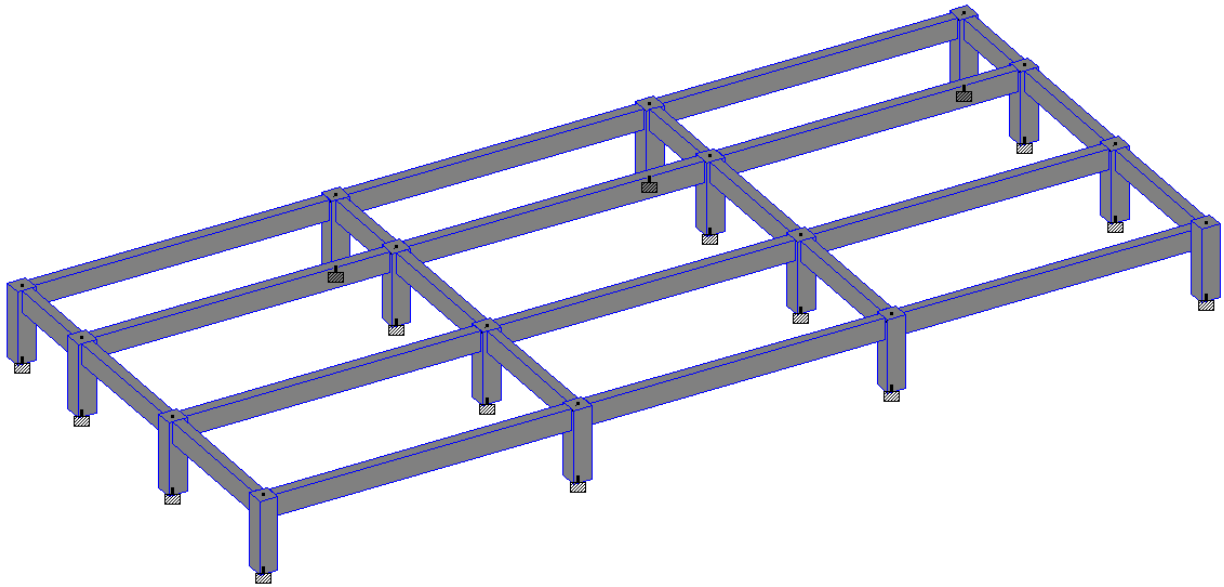


Diagram showing 12 numbered points (likely nodes or supports) arranged in a grid pattern, corresponding to the structure above:

- Points 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 are distributed across the grid.

REACTIONS AT SUPPORT NODES (SUBSTRUCTURE)

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
17	216 COMB	-18.592	22.181	0.389	-9.178	-2.459	73.757
	217 COMB	-19.795	35.397	3.917	-3.459	-1.872	77.138
	218 COMB	22.118	144.593	14.022	12.799	1.775	-71.233
18	216 COMB	-52.002	183.107	-4.238	-8.53	-2.378	83.829
	217 COMB	-54.453	188.529	-3.391	-6.889	-1.823	87.576
	218 COMB	47.861	195.238	-1.013	-2.233	1.548	-78.573
19	216 COMB	-50.926	214.52	4.188	4.113	-2.465	83.69
	217 COMB	-53.379	208.35	2.88	1.93	-1.909	87.438
	218 COMB	48.945	199.118	-0.764	-4.231	1.453	-78.732
20	216 COMB	-23.447	199.306	9.993	14.521	-2.72	75.846
	217 COMB	-24.646	183.237	6.218	8.311	-2.133	79.227
	218 COMB	17.075	65.724	-4.624	-9.415	1.507	-69.133
21	216 COMB	-30.546	259.784	-8.522	-11.825	-2.035	89.666
	217 COMB	-31.047	250.195	-1.756	-5.044	-1.489	91.406
	218 COMB	24.531	323.192	17.504	14.217	1.742	-84.403
22	216 COMB	-61.195	499.716	-9.705	-10.329	-1.98	99.469
	217 COMB	-62.374	496.5	-7.803	-8.351	-1.457	101.409
	218 COMB	60.053	466.583	-2.424	-2.734	1.534	-94.12
23	216 COMB	-64.285	444.992	5.605	4.615	-2.078	101.191
	217 COMB	-65.465	448.779	3.016	2.013	-1.554	103.13
	218 COMB	56.903	480.747	-4.264	-5.336	1.475	-92.373
24	216 COMB	-27.265	307.009	17.795	17.091	-2.245	90.995
	217 COMB	-27.767	319.086	10.453	9.715	-1.699	92.735
	218 COMB	27.944	253.507	-10.538	-11.324	1.52	-83.089
25	216 COMB	-29.946	181.29	-2.278	-9.036	-0.978	91.099
	217 COMB	-29.623	183.251	2.892	-2.723	-0.383	90.057
	218 COMB	27.734	281.658	17.524	15.173	0.801	-92.872

REACTIONS AT SUPPORT NODES (CONT.) (SUBSTRUCTURE)

26	216 COMB	-62.715	368.816	-9.422	-10.369	-1.27	101.526
	217 COMB	-61.968	369.166	-8.15	-8.607	-0.684	100.358
	218 COMB	66.095	353.85	-4.535	-3.596	0.945	-103.427
27	216 COMB	-64.445	365.508	3.934	4.207	-1.101	102.916
	217 COMB	-63.717	365.154	1.927	1.778	-0.536	101.755
	218 COMB	64.048	380.377	-3.739	-5.091	0.623	-101.901
28	216 COMB	-25.811	278.321	13.353	15.808	-1.149	92.304
	217 COMB	-25.484	276.714	7.653	8.922	-0.552	91.261
	218 COMB	32.085	179.303	-8.588	-10.688	0.666	-91.687
29	216 COMB	-34.405	499.483	-16.085	-12.66	-1.462	90.369
	217 COMB	-33.204	493.911	-14.439	-7.422	-0.807	86.661
	218 COMB	20.597	588.182	-9.749	7.431	0.913	-94.015
30	216 COMB	-59.992	579.195	-3.266	-8.632	1.382	99.48
	217 COMB	-57.136	580.488	-2.25	-6.966	1.764	95.289
	218 COMB	70.516	560.832	0.639	-2.224	-1.812	-107.069
31	216 COMB	-60.574	533.797	-0.682	2.851	-1.575	101.526
	217 COMB	-57.969	536.559	-1.294	0.851	-0.963	97.401
	218 COMB	65.867	563.146	-2.992	-4.793	0.656	-103.833
32	216 COMB	-21.558	353.087	2.992	12.653	-1.549	91.336
	217 COMB	-20.285	358.744	1.083	6.932	-0.904	87.593
	218 COMB	35.898	269.536	-4.426	-9.377	0.574	-93.67

NOTE:

LOAD COMBINATIONS:

- 216 (1.42 DL + .5 LL + 1 EQ +X +E)
- 217 (1.44 DL + .5 LL + 1 EQ +X -E)
- 218 (1.44 DL + .5 LL + 1 EQ -X +E)

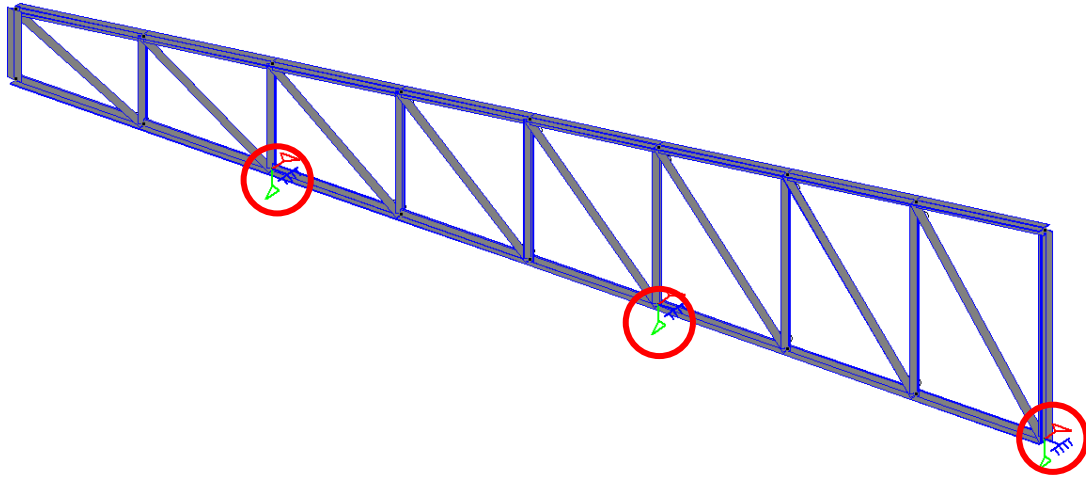
produces the most crucial loading to the columns and to the support nodes.

Note: Reactions from the structural analysis were gathered using second-order analysis, considering both $P - \Delta$ and $P - \delta$ effects.

SUPPORT REACTIONS

(TRUSS T - 1)

PROPOSED TWO STOREY COMMERCIAL BUILDING



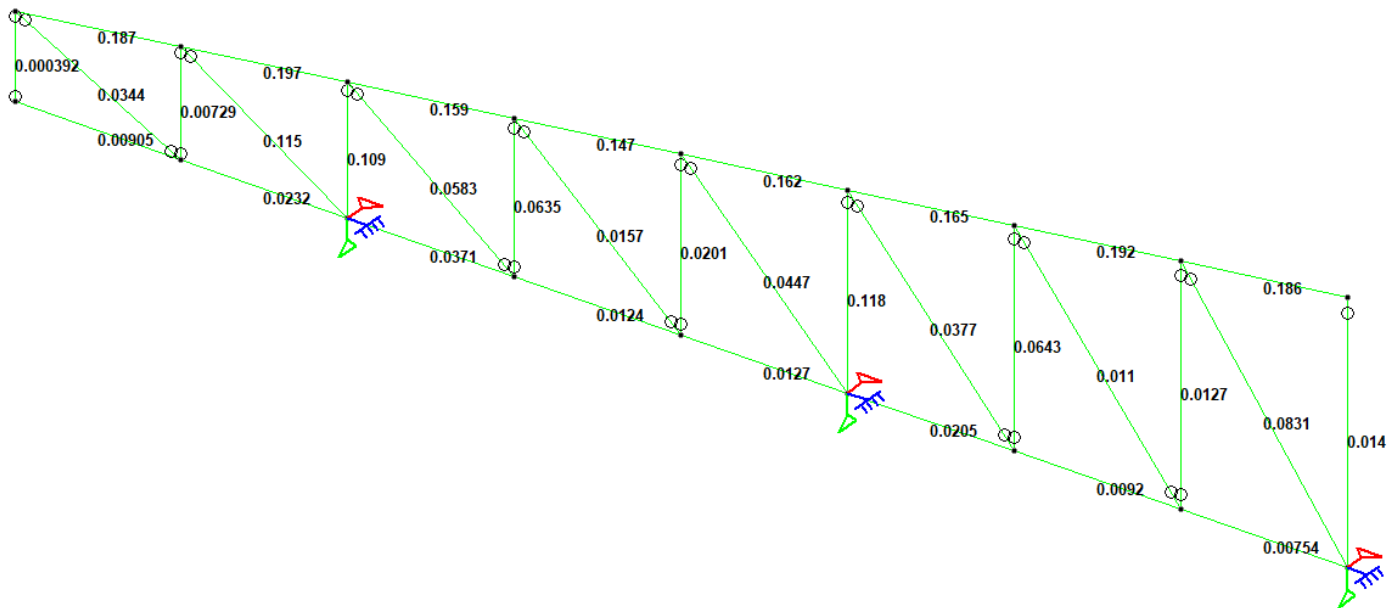
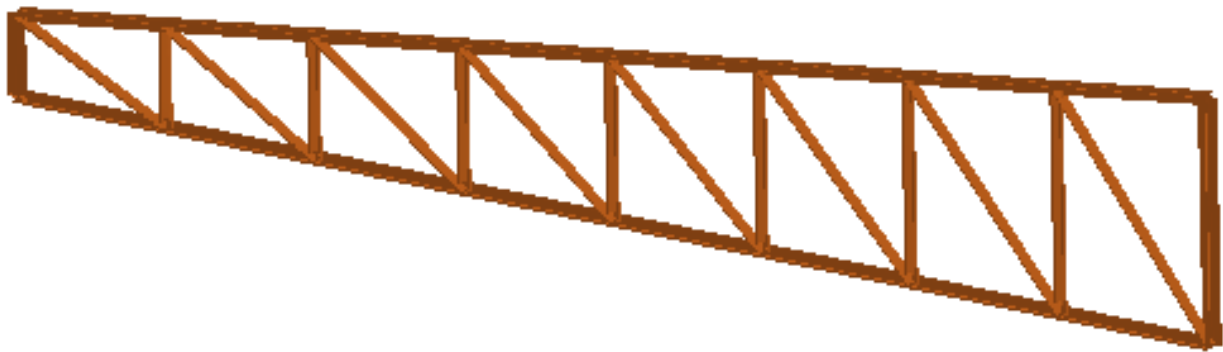
REACTIONS AT SUPPORT NODES

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
3	1 DL	0	3.137	-0.849	0	0	0
	2 LL	0	9.926	-2.644	0	0	0
6	1 DL	0	2.349	0.974	0	0	0
	2 LL	0	7.2	3.041	0	0	0
9	1 DL	0	1.093	-0.125	0	0	0
	2 LL	0	3.163	-0.397	0	0	0

UTILIZATION RATIO

(TRUSS T - 1)

PROPOSED TWO STOREY COMMERCIAL BUILDING

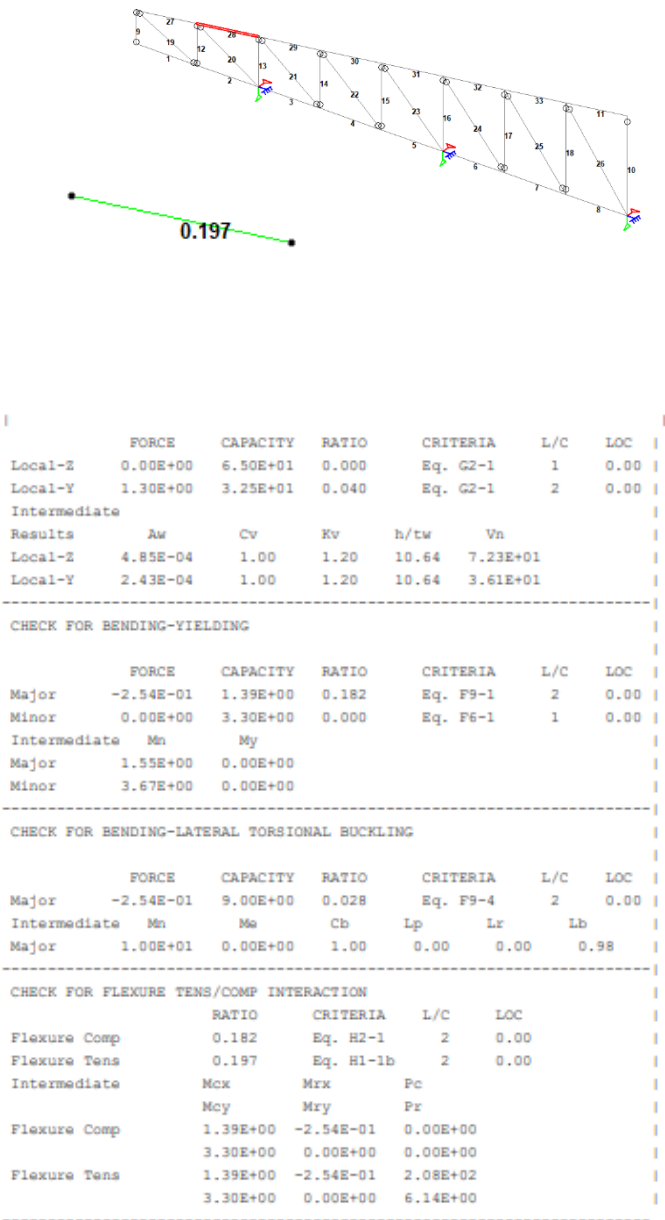


MOST CRITICAL $2 < 2 \times 2 \times 3/16$

MEMBER 28

Steel Design (Track 2) Beam 28 Check 1

28 LD	L20203	(AISC SECTIONS)				
	PASS	Eq. H1-1b	0.197	2		
	6.14 T	0.00	0.25	0.00		
SLENDERNESS						
Actual Slenderness Ratio	:	62.929	L/C	: 2		
Allowable Slenderness Ratio	:	300.000	LOC	: 0.00		
STRENGTH CHECKS						
Critical L/C	:	2	Ratio	: 0.197(PASS)		
Loc	:	0.00	Condition	: Eq. H1-1b		
DESIGN FORCES						
Fx:	6.144E+00 (T)	Fy:	1.295E+00	Fz:	0.000E+00	
Mx:	0.000E+00	My:	0.000E+00	Mz:	2.538E-01	
SECTION PROPERTIES (UNIT: CM)						
Azz:	4.852E+00	Ayy:	2.426E+00	Cw:	0.000E+00	
Szz:	6.237E+00	Syy:	9.230E+00			
Izz:	2.273E+01	Iyy:	4.919E+01	Ix:	7.081E-01	
MATERIAL PROPERTIES						
Fyld:	248211.281	Fu:	399895.953			
Actual Member Length: 0.983						
Design Parameters						
Kz:	1.00	Ky:	1.00	NSF:	1.00	
			SLF:	1.00	CSP:	12.00
SECTION CLASS UNSTIFFENED / STIFFENED						
Compression	:	Non-Slender	10.64	N/A	12.93	T.B4.1(a)-3
		N/A	N/A	N/A	N/A	N/A
Flexure	:	Compact	10.64	15.52	26.15	T.B4.1(b)-12
		N/A	N/A	N/A	N/A	N/A
CHECK FOR AXIAL TENSION						
	FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Yield	6.47E+00	2.08E+02	0.031	Eq. D2-1	2	0.98
Rupture	6.47E+00	2.79E+02	0.023	Eq. D2-2	2	0.98
CHECK FOR AXIAL COMPRESSION						
	FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Maj Buck	0.00E+00	1.70E+02	0.000	Eq. E3-1	1	0.00
Min Buck	0.00E+00	1.89E+02	0.000	Eq. E3-1	1	0.00
Flexural						
Tor Buck	0.00E+00	1.76E+02	0.000	Eq. E4-1	1	0.00
Intermediate						
Results	Eff Area	KL/r	Fcr	Fe	Pn	
Maj Buck	9.32E-04	62.93	2.03E+05	5.11E+05	1.89E+02	
Min Buck	9.32E-04	42.78	2.26E+05	1.11E+06	2.10E+02	
Flexural Ag						
Tor Buck	0.00E+00	2.10E+05	1.96E+02			
CHECK FOR SHEAR						



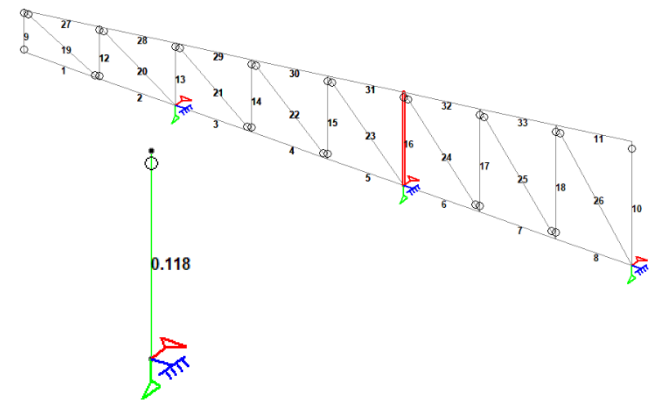
NOTE: *Utilization Ratio < 1 means section capacity is adequate.

MOST CRITICAL < 2 x 2 x 3/16

MEMBER 16

Steel Design (Track 2) Beam 16 Check 1

16 ST	L20203	(AISC SECTIONS)			
PASS	Eq. H2-1	0.118	2		
5.88 C	-0.00	0.00	0.00		
SLENDERNES					
Actual Slenderness Ratio	:	117.617	L/C	:	2
Allowable Slenderness Ratio	:	200.000	LOC	:	0.00
STRENGTH CHECKS					
Critical L/C	:	2	Ratio	:	0.118 (PASS)
Loc	:	0.00	Condition	:	Eq. H2-1
DESIGN FORCES					
Fx:	5.884E+00 (C)	Fy:	0.000E+00	Fz:	-4.103E-03
Mx:	0.000E+00	My:	0.000E+00	Mz:	-4.616E-03
SECTION PROPERTIES (UNIT: CM)					
Azz:	2.426E+00	Ayy:	2.426E+00	Cw:	6.864E-01
Szz:	2.314E+00	Syy:	5.020E+00		
Izz:	4.547E+00	Iyy:	1.818E+01	Ix:	3.541E-01
MATERIAL PROPERTIES					
Fyld:	248211.281	Fu:	399895.953		
Actual Member Length:	1.125				
Design Parameters					
Kz:	1.00	Ky:	1.00 NSF:	1.00 SLF:	1.00 CSP:
					12.00
SECTION CLASS UNSTIFFENED / STIFFENED					
Compression	: Non-Slender	10.64	N/A	12.93	T.B4.1(a)-3
	N/A	N/A	N/A	N/A	N/A
Flexure	: Compact	10.64	15.52	26.15	T.B4.1(b)-12
	N/A	N/A	N/A	N/A	N/A
CHECK FOR AXIAL TENSION					
	FORCE	CAPACITY	RATIO	CRITERIA	L/C LOC
Yield	0.00E+00	1.04E+02	0.000	Eq. D2-1	1 0.00
Rupture	0.00E+00	1.40E+02	0.000	Eq. D2-2	1 0.00
CHECK FOR AXIAL COMPRESSION					
	FORCE	CAPACITY	RATIO	CRITERIA	L/C LOC
Min Buck	5.88E+00	5.11E+01	0.115	Eq. E3-1	2 0.00
Intermediate					
Results	Eff Area	KL/r	Fcr	Fe	Pn
Min Buck	4.66E-04	117.62	1.22E+05	1.46E+05	5.68E+01
CHECK FOR SHEAR					
	FORCE	CAPACITY	RATIO	CRITERIA	L/C LOC
Local-Z	4.10E-03	3.25E+01	0.000	Eq. G2-1	2 0.00
Local-Y	0.00E+00	3.25E+01	0.000	Eq. G2-1	1 0.00
Intermediate					
Results	Aw	Cv	Kv	h/tw	Vn



Local-Z	2.43E-04	1.00	1.20	10.64	3.61E+01
Local-Y	2.43E-04	1.00	1.20	10.64	3.61E+01
CHECK FOR BENDING-YIELDING					
	FORCE	CAPACITY	RATIO	CRITERIA	L/C LOC
Major	4.62E-03	1.68E+00	0.003	Eq. F10-1	2 0.00
Minor	0.00E+00	7.75E-01	0.000	Eq. F10-1	1 0.00
Intermediate	Mn	My			
Major	1.87E+00	1.25E+00			
Minor	8.61E-01	5.74E-01			
CHECK FOR BENDING-LATERAL TORSIONAL BUCKLING					
	FORCE	CAPACITY	RATIO	CRITERIA	L/C LOC
Major	4.62E-03	1.49E+00	0.003	Eq. F10-3	2 0.00
Intermediate	Mn	Me	Cb	Lp	Lr Lb
Major	1.66E+00	4.93E+00	1.00	0.00	0.00 1.13
CHECK FOR SHEAR AND NORMAL STRESS INTERACTION					
	STRESS	RATIO	CRITERIA	L/C LOC	
Shear	1.34E+05	0.000	Eq. H3-8	2	0.00
CHECK FOR FLEXURE TENS/COMP INTERACTION					
	RATIO	CRITERIA	L/C LOC		
Flexure Comp	0.118	Eq. H2-1	2	0.00	
Flexure Tens	0.003	Eq. H2-1	2	0.00	
Intermediate	Mcx	Mrx	Pc		
	Mcy	Mry	Pr		
Flexure Comp	1.49E+00	4.62E-03	0.00E+00		
	7.75E-01	0.00E+00	0.00E+00		
Flexure Tens	1.49E+00	4.62E-03	0.00E+00		
	7.75E-01	0.00E+00	0.00E+00		
GEOMETRIC AXIS DESIGN					
CHECK FOR BENDING-YIELDING					
	FORCE	CAPACITY	RATIO	CRITERIA	L/C LOC
Major	3.26E-03	1.04E+00	0.003	Eq. F10-1	2 0.00
Minor	3.26E-03	1.04E+00	0.003	Eq. F10-1	2 0.00
Intermediate	Mn	My			
Major	1.16E+00	7.74E-01			
Minor	1.16E+00	7.74E-01			
CHECK FOR BENDING-LATERAL TORSIONAL BUCKLING					
	FORCE	CAPACITY	RATIO	CRITERIA	L/C LOC
Major	3.26E-03	8.04E-01	0.004	Eq. F10-3	2 0.00
Minor	3.26E-03	8.36E-01	0.004	Eq. F10-3	2 0.00
Intermediate	Mn	Me	Cb	Lp	Lr Lb
Major	8.93E-01	3.72E+00	1.00	0.00	0.00 1.13
Minor	9.29E-01	1.05E+01	1.00	0.00	0.00 1.13

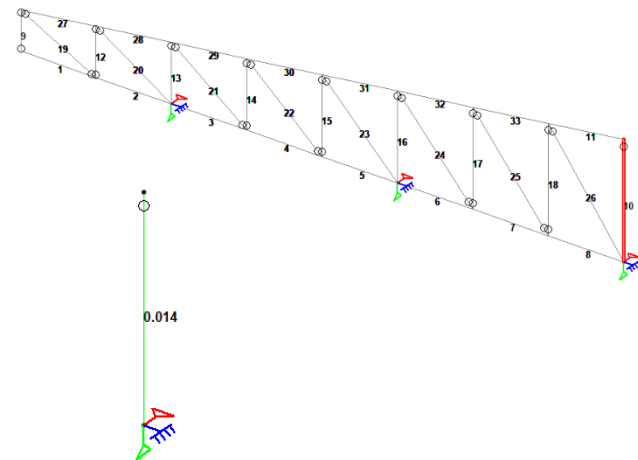
NOTE: *Utilization Ratio < 1 means section capacity is adequate.

MOST CRITICAL < 2 x 2 x 1/8

MEMBER 10

Steel Design (Track 2) Beam 10 Check 1

10 LD	L20202	(AISC SECTIONS)					
PASS		Eq. H2-1		0.014	2		
1.00 C		-0.00		0.00	0.00		
SLENDERNES							
Actual Slenderness Ratio		:	94.938	L/C	:	2	
Allowable Slenderness Ratio		:	200.000	LOC	:	0.00	
STRENGTH CHECKS							
Critical L/C		:	2	Ratio	:	0.014(PASS)	
Loc		:	0.00	Condition	:	Eq. H2-1	
DESIGN FORCES							
Fx:		1.004E+00 (C)	Fy:	0.000E+00	Fz:	3.085E-03	
Mx:		0.000E+00	My:	-4.627E-03	Mz:	0.000E+00	
SECTION PROPERTIES (UNIT: CM)							
Azz:		3.226E+00	Ayy:	1.613E+00	Cw:	0.000E+00	
Szz:		4.262E+00	Syy:	6.083E+00			
Izz:		1.582E+01	Iyy:	3.242E+01	Ix:	2.129E-01	
MATERIAL PROPERTIES							
Fyld:		248211.281	Fu:	399895.953			
Actual Member Length:						1.500	
Design Parameters							
Kz:		1.00	Ky:	1.00	NSF:	1.00	
SLF:		1.00	CSP:	12.00			
SECTION CLASS		UNSTIFFENED / STIFFENED					CASE
Compression		:	Slender	16.00	N/A	12.93	T.B4.1(a)-3
			N/A	N/A	N/A	N/A	N/A
Flexure		:	Non-Compact	16.00	15.52	26.15	T.B4.1(b)-12
			N/A	N/A	N/A	N/A	N/A
CHECK FOR AXIAL TENSION							
		FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Yield		0.00E+00	1.42E+02	0.000	Eq. D2-1	1	0.00
Rupture		0.00E+00	1.90E+02	0.000	Eq. D2-2	1	0.00
CHECK FOR AXIAL COMPRESSION							
		FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Maj Buck		1.00E+00	8.49E+01	0.012	Eq. E7-1	2	0.00
Min Buck		1.00E+00	1.06E+02	0.010	Eq. E7-1	2	0.00
Flexural							
Tor Buck		1.00E+00	8.81E+01	0.011	Eq. E7-1	2	0.00
Intermediate							
Results		Eff Area	KL/r	Fcr	Fe	Pn	
Maj Buck		6.34E-04	94.94	1.49E+05	2.24E+05	9.43E+01	
Min Buck		6.34E-04	66.31	1.85E+05	4.60E+05	1.17E+02	
Flexural		Ag	Fcr	Pn			
Tor Buck		6.34E-04	1.55E+05	9.79E+01			
CHECK FOR SHEAR							



	FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Local-Z	-4.75E-03	4.32E+01	0.000	Eq. G2-1	1	0.00
Local-Y	0.00E+00	2.16E+01	0.000	Eq. G2-1	1	0.00
Intermediate						
Results	Aw	Cv	Kv	h/tw	Vn	
Local-Z	3.23E-04	1.00	1.20	16.00	4.80E+01	
Local-Y	1.61E-04	1.00	1.20	16.00	2.40E+01	

CHECK FOR BENDING-YIELDING						
	FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Major	0.00E+00	1.52E+00	0.000	Eq. F9-1	1	0.00
Minor	-7.12E-03	2.17E+00	0.003	Eq. F6-1	1	0.00
Intermediate Mn My						
Major	1.69E+00	0.00E+00				
Minor	2.42E+00	0.00E+00				

CHECK FOR BENDING-LATERAL TORSIONAL BUCKLING						
	FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Major	0.00E+00	1.48E+01	0.000	Eq. F9-4	1	0.00
Intermediate Mn Mb Cb Lp Lr Lb						
Major	1.64E+01	0.00E+00	1.00	0.00	0.00	1.50

CHECK FOR BENDING-FLANGE LOCAL BUCKLING						
	FORCE	CAPACITY	RATIO	CRITERIA	L/C	LOC
Major	0.00E+00	1.54E+00	0.000	Eq. F9-6	1	0.00
Minor	-7.12E-03	2.12E+00	0.003	Eq. F6-2	1	0.00
Intermediate Mn Pcr						
Major	1.71E+00	0.00E+00				
Minor	2.35E+00	0.00E+00				

CHECK FOR FLEXURE TENS/COMP INTERACTION						
	RATIO	CRITERIA	L/C	LOC		
Flexure Comp	0.014	Eq. H2-1	2	0.00		
Flexure Tens	0.003	Eq. H1-1b	1	0.00		
Intermediate Mcx Mrx Pc						
	Mcy Mry	Pr				
Flexure Comp	1.52E+00	0.00E+00	0.00E+00			
	2.12E+00	-4.63E-03	0.00E+00			
Flexure Tens	1.52E+00	0.00E+00	1.42E+02			
	2.12E+00	-7.12E-03	0.00E+00			

NOTE: *Utilization Ratio < 1 means section capacity is adequate.

UTILIZATION RATIO TABLE

Utilization Ratio

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm ²)	Iz (cm ⁴)	Iy (cm ⁴)	Ix (cm ⁴)
10	L20202	L20202 LI	0.014	1.000	0.014	Eq. H2-1	2	8.335	15.815	32.423	0.213
16	L20203	L20203	0.118	1.000	0.118	Eq. H2-1	2	4.658	4.547	18.183	0.354
28	L20203	L20203 LI	0.197	1.000	0.197	Eq. H1-1b	2	9.316	22.731	49.195	0.708

FAILED MEMBERS TABLE

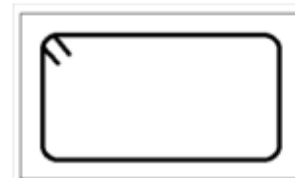
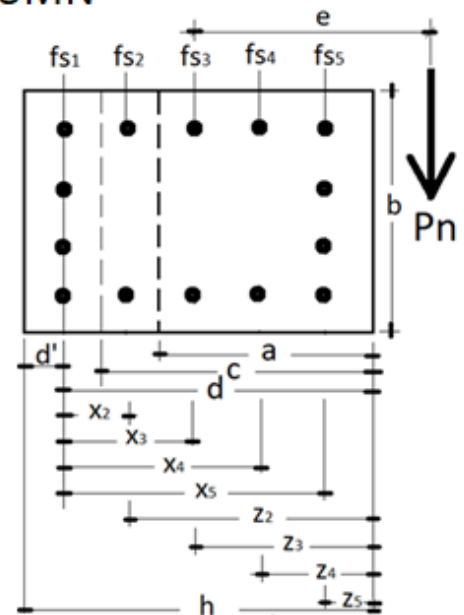
Failed Members

There is no data of this type.

COLUMNS

PROPOSED TWO STOREY COMMERCIAL BUILDING

C - 1A / Column No. 1104



Therefore use, 350x350mm 8-16mm Ø longitudinal bars (GRADE 40) with 10mm Ø lateral ties space at, 1@50, 8@80mm , and Rest 150mm O.C, BOTH ENDS.

REINFORCED CONCRETE COLUMN

C - 1B / Column No. 2108

Design Parameters:

h = 350 mm	d' = 60 mm
b = 350 mm	Main bars = 20 mm ϕ
fc' = 21 Mpa	Mux = 23.880325 KNm
fy = 275 Mpa	Pu = 241.34177 KN
b ₁ = 0.85	Escon = 600 Mpa
Es = 200 Gpa	

Defining Condition:

ϕ =	0.65	, $\epsilon_t \leq \epsilon_{ty}$	if $f_s > f_y$, use f_y
	Val	, $\epsilon_{ty} < \epsilon_t < 0.005$	
	0.90	, $\epsilon_t \geq 0.005$	

Val = Use 0.65 in transition Region

MAXIMUM AXIAL CAPACITY Ag = 122500 NSCP 422.4.2.2

$$P_{cn} = 0.8 [0.85 f'_c (A_g - A_s) + f_y A_s] = 2,173.27 \text{ kN}$$

$$\phi = 0.65, P_{cu} = \phi P_{cn} = 1,412.62 \text{ kN}$$

BALANCE CONDITION CAPACITY, $\phi = 0.65$

$\epsilon_y = f_y / E_s = 0.00138$
$C_b = \epsilon_c d / \epsilon_c + \epsilon_y = 198.86 \text{ mm}$
$a_b = \beta C = 169.03 \text{ mm}$

from strain diagram

fs	As[fy or fs]
fs1 = 600(d-C)/C = 275.00	T1 = 172.79 KN, Tension
fs2 = 600(C-Z2)/C = -43.68	C2 = -17.56 KN, Tension
fs3 = 600(C-Z3)/C = 0.00	C3 = 0.00 KN,
fs4 = 600(C-Z4)/C = 187.64	C4 = 75.46 KN, Compression
fs5 = 600(C-Z5)/C = 418.97	C5 = 172.79 KN, Compression
Cc = .85 f'_c ab = 1056.006 KN	

$$[\sum F_v = 0], P_{bn} = C2 + C3 + C4 + C5 + C_c - T = 1113.9 \text{ KN}$$

$$[\sum M_T = 0], \text{ find } e = x - z, z = 115.00 \text{ mm}$$

$$P_{bn} X = C2 X2 + C3 X3 + C4 X4 + C5 X5 + C_c X_c$$

eb = 124.66 mm	$\phi P_b = 724.0 \text{ KN}$
Mb = 138.86 KNm	$\phi M_b = 90.26 \text{ KNm}$

ECENTRICALLY LOADED SECTION CAPACITY, $\phi = .65$

due to applied load, ex = 98.95

$$[\sum F_v = 0], P_{bn} = C2 + C3 + C4 + C5 + C_c - T$$

$$[\sum M_T = 0], P_{bn} X = C2 X2 + C3 X3 + C4 X4 + C5 X5 + C_c X_c$$

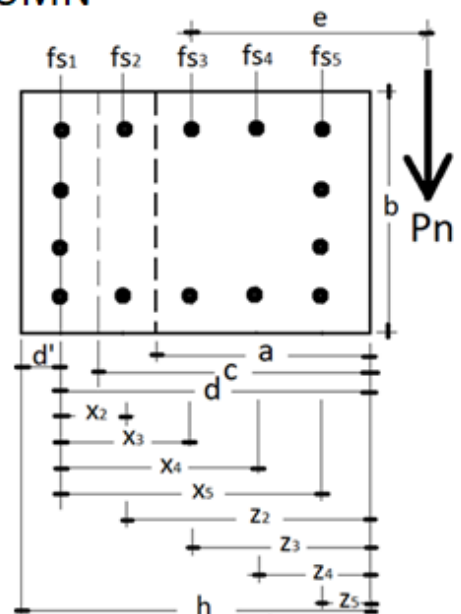
C = 221.24 mm	a = 188.05 mm
fs1 = 600(d-C)/C = 186.48	T1 = 117.17 KN, Tension
fs2 = 600(C-Z2)/C = 21.44	C2 = 8.62 KN, Compression
fs3 = 600(C-Z3)/C = 0.00	C3 = 0.00 KN,
fs4 = 600(C-Z4)/C = 229.36	C4 = 92.23 KN, Compression
fs5 = 600(C-Z5)/C = 437.28	C5 = 172.79 KN, Compression
Cc = .85 f'_c ab = 1174.87	

Pnx = 1331.34	$\phi P_n = 865.37 \text{ KN}$	>	241.34	Pass!
Mnx = 131.73	$\phi M_n = 85.63 \text{ KNm}$	>	23.88	Pass!

Main Bars	Loc-Z	Ast
fs1 = 2	-	290.00
fs2 = 2	-	213.33
fs3 = 0	-	213.33
fs4 = 2	-	136.67
fs5 = 2	-	60.00

Shear parameters

Nvh = 3	, lateral ties leg
Nvb = 3	, lateral ties leg
fyt = 230	Mpa, lateral ties
Ties, Td = 10	mm ϕ



COMPRESSION CONTROLLED CAPACITY, $\phi = .65$

$$\epsilon_t = -0.002$$

$$C_t = \epsilon_{scon} d / (\epsilon_{scon} - \epsilon_s \epsilon_t) = 174.00 \text{ mm}$$

$$a_t = \beta C = 147.90 \text{ mm}$$

from strain diagram

fs	As[fy or fs]
fs1 = 600(d-C)/C = 400.00	T1 = 172.79 KN, T
fs2 = 600(C-Z2)/C = -135.63	C2 = -54.54 KN, T
fs3 = 600(C-Z3)/C = 0.00	C3 = 0.00 KN,
fs4 = 600(C-Z4)/C = 128.74	C4 = 51.77 KN, C
fs5 = 600(C-Z5)/C = 393.10	C5 = 172.79 KN, C
Cc = .85 f'_c ab = 924.005 KN	

$$[\sum F_v = 0], P_{bn} = C2 + C3 + C4 + C5 + C_c - T = 921.2 \text{ KN}$$

$$[\sum M_T = 0], \text{ find } e = x - z, z = 115 \text{ mm}$$

$$P_{bn} X = C2 X2 + C3 X3 + C4 X4 + C5 X5 + C_c X_c$$

et = 101.70 mm	$\phi P_t = 598.80 \text{ KN}$
Mt = 60.90 KNm	$\phi M_t = 39.58 \text{ KNm}$

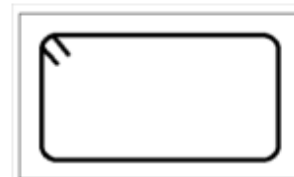
CHECK SHEAR, $\phi_v = 0.75$

$$V_c = 0.17 [1 + (P_u / 14 A_g)] \sqrt{f'_c} b d t = 90.20 \text{ KN}$$

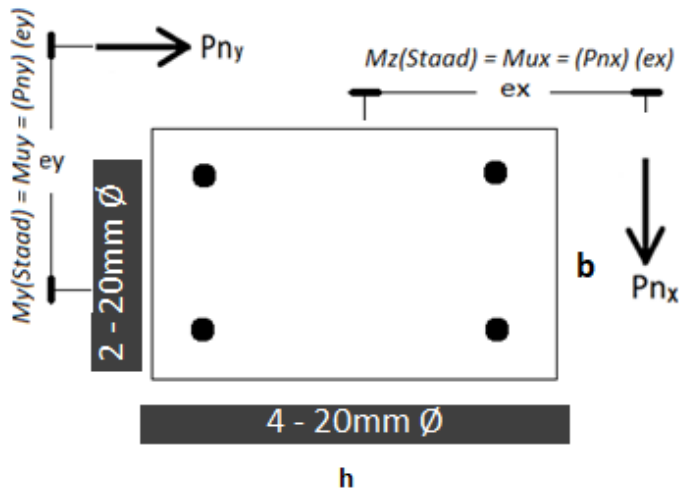
$$A_v = \pi T d^2 N_v / 4 = 235.6 \text{ mm}^2$$

Smax, min (16db, 48dties and least col dimension)

16 db	= 320 mm
48 dties	= 480 mm
Least Column dimension	= 350 mm



Therefore use, 350x350mm 8-20mm ϕ longitudinal bars (GRADE 40) with 10mm ϕ lateral ties space at, 1@50, 6@80mm, and Rest 150mm O.C, BOTH ENDS.



FORCE TRANSFER GUIDE FROM STAAD RESULT OR EQUIVALENT SOFTWARE

$M_z \text{ (Staad)} = M_{ux} = 23.8803 < 85.63$ **Pass!** , $e_x = 98.95 \text{ mm}$
 $M_y \text{ (Staad)} = M_{uy} = 65.9644 < 136.19$ **Pass!** , $e_y = 273.32 \text{ mm}$
 $\phi P_{nx} = 865.37 > 241.341766357422$ **Pass!**
 $\phi P_{ny} = 498.27 > 241.341766357422$ **Pass!**

Col Height, $H = 3$ Floor to Beam Bottom
 Length factor, $K = 0.5$ Refer (Sheet 2)

Column Slenderness (Unbraced Column, $KL/r \leq 22$), 406.2.5

$KL/r_x = 14.29 < 22$ **Ok!**
 $KL/r_y = 14.29 < 22$ **Ok!**

Dimension Limits, 418.7.2.1

250 mm ∇ 350 **Ok!**

Main reinforcement Ratio

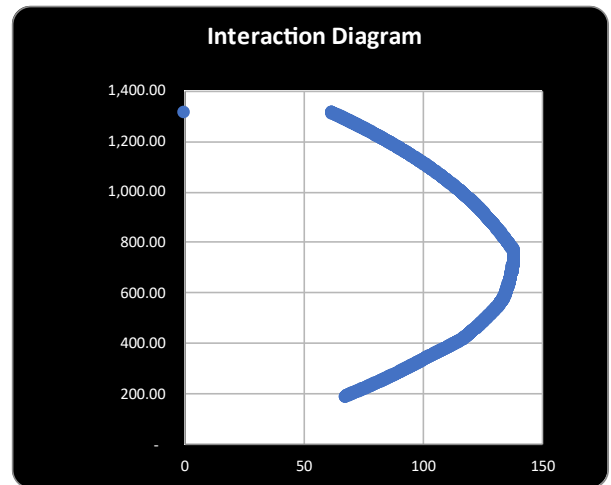
$A_{st} = 2060.88$

$0.01A_g < A_{st} > 0.06A_g$ **Ok!**

Traverse Reinforcements, 418.7.5.4

No of Leg Req, $h = 3$ **Ok!** **Apply on Lo and Joints only**

No of Leg Req, $b = 3$ **Ok!** **Apply on Lo and Joints only**



Side	h	m	With Seismic Provision, NSCP 2015 Sec 418.7.5					
H	Col mark	Vu	Vs	Smax	Seismic req	QTY	DIST	
Lo	0 - 0.05m	9.10248	(78.06)	201.32	50	1	50	Pass!
	0.05 - 0.5m	9.10248	(78.06)	201.32	80	6	80	Pass!
Mid	> 0.5m	9.10248	(78.06)	201.32	120	Rest	150	Ok! Sx

$V_s = (V_u / \phi) - V_c$
 $S = A_v f_y d / V_s$

First lat ties Min of 50mm from Face of Support

REINFORCED CONCRETE COLUMN

C - 2A / Column No. 1116

Design Parameters:

h =	350	mm	d' =	58	mm
b =	350	mm	Main bars =	16	mm ϕ
fc' =	21	Mpa	Mux =	26.005592	KNm
fy =	275	Mpa	Pu =	342.78275	KN
b ₁ =	0.85		Escon =	600	Mpa
Es =	200	Gpa			

Defining Condition:

ϕ =	0.65	, $\epsilon_t \leq \epsilon_{ty}$	if $f_s > f_y$, use f_y
	Val	, $\epsilon_{ty} < \epsilon_t < 0.005$	
	0.90	, $\epsilon_t \geq 0.005$	
Val = Use 0.65 in transition Region			

MAXIMUM AXIAL CAPACITY Ag = 122500 NSCP 422.4.2.2

$$P_{cn} = 0.8 [0.85 f'_c (A_g - A_s) + f_y A_s] = 2,080.20 \text{ kN}$$

$$\phi = 0.65, P_{cu} = \phi P_{cn} = 1,352.13 \text{ kN}$$

BALANCE CONDITION CAPACITY, $\phi = 0.65$

$$\epsilon_y = f_y / E_s = 0.00138$$

$$C_b = \epsilon_c d / \epsilon_c + \epsilon_y = 200.23 \text{ mm}$$

$$a_b = \beta C = 170.19 \text{ mm}$$

from strain diagram

As[f_y or f_s]

fs1 =	600(d-C)/C =	275.00	T1 =	110.58	KN, Tension
fs2 =	600(C-Z2)/C =	-41.27	C2 =	-16.59	KN, Tension
fs3 =	600(C-Z3)/C =	0.00	C3 =	0.00	KN,
fs4 =	600(C-Z4)/C =	192.47	C4 =	77.40	KN, Compression
fs5 =	600(C-Z5)/C =	426.20	C5 =	110.58	KN, Compression
Cc =		.85 f'c ab =	1063.2888	KN	

$$[\Sigma F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T = 1124.1 \text{ KN}$$

$$[\Sigma M_T = 0], \text{ find } e = x - z, z = 117.00 \text{ mm}$$

$$P_{bn} X = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$e_b = 111.32 \text{ mm} \quad \phi P_b = 730.7 \text{ KN}$$

$$M_b = 125.13 \text{ KNm} \quad \phi M_b = 81.34 \text{ KNm}$$

ECCENTRICALLY LOADED SECTION CAPACITY, $\phi = .65$

due to applied load, ex = 75.87

$$[\Sigma F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T$$

$$[\Sigma M_T = 0], P_{bn} X = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$C = 244.44 \text{ mm} \quad a = 207.78 \text{ mm}$$

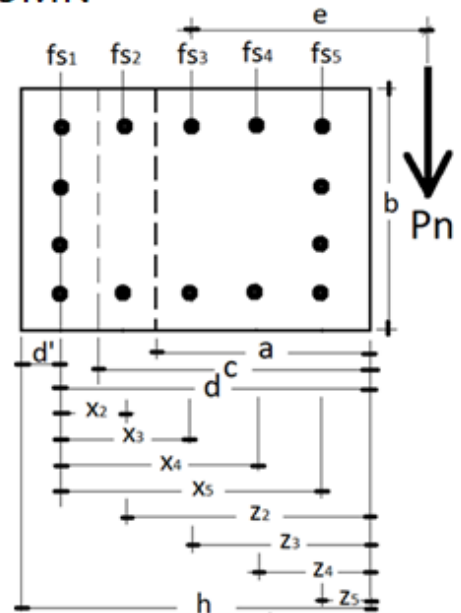
fs1 =	600(d-C)/C =	116.73	T1 =	46.94	KN, Tension
fs2 =	600(C-Z2)/C =	74.72	C2 =	30.05	KN, Compression
fs3 =	600(C-Z3)/C =	0.00	C3 =	0.00	KN,
fs4 =	600(C-Z4)/C =	266.18	C4 =	107.04	KN, Compression
fs5 =	600(C-Z5)/C =	457.63	C5 =	110.58	KN, Compression
Cc =		.85 f'c ab =	1298.08	KN	

Pnx =	1498.81	ϕP_n =	974.22	KN	>	342.78	Pass!
Mnx =	113.71	ϕM_n =	73.91	KNm	>	26.01	Pass!

Main Bars	Loc-Z	Ast
fs1 = 2	-	292.00
fs2 = 2	-	214.00
fs3 = 0	-	214.00
fs4 = 2	-	136.00
fs5 = 2	-	58.00

Shear parameters

Nvh =	3	, lateral ties leg
Nvb =	3	, lateral ties leg
fyt =	230	Mpa, lateral ties
Ties, Td =	10	mm ϕ



COMPRESSION CONTROLLED CAPACITY, $\phi = .65$

$$\epsilon_t = -0.002$$

$$C_t = \epsilon_{sc} d / (\epsilon_{sc} - \epsilon_t) = 175.20 \text{ mm}$$

$$a_t = \beta C = 148.92 \text{ mm}$$

from strain diagram

As[f_y or f_s]

fs1 =	600(d-C)/C =	400.00	T1 =	110.58	KN, T
fs2 =	600(C-Z2)/C =	-132.88	C2 =	-53.43	KN, T
fs3 =	600(C-Z3)/C =	0.00	C3 =	0.00	KN,
fs4 =	600(C-Z4)/C =	134.25	C4 =	53.98	KN, C
fs5 =	600(C-Z5)/C =	401.37	C5 =	110.58	KN, C
Cc =		.85 f'c ab =	930.378	KN	

$$[\Sigma F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T = 930.9 \text{ KN}$$

$$[\Sigma M_T = 0], \text{ find } e = x - z, z = 117 \text{ mm}$$

$$P_{bn} X = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$e_t = 100.41 \text{ mm} \quad \phi P_t = 605.10 \text{ KN}$$

$$M_t = 60.76 \text{ KNm} \quad \phi M_t = 39.49 \text{ KNm}$$

CHECK SHEAR, $\phi_v = 0.75$

$$V_c = 0.17 [1 + (P_u / 14 A_g)] \sqrt{f'_c} b d t = 95.53 \text{ KN}$$

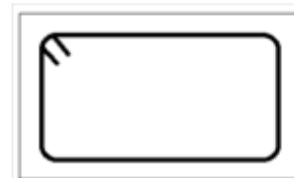
$$A_v = \pi T d^2 N_v / 4 = 235.6 \text{ mm}^2$$

Smax, min (16db, 48dties and least col dimension)

$$16 \text{ db} = 256 \text{ mm}$$

$$48 \text{ dties} = 480 \text{ mm}$$

$$\text{Least Column dimension} = 350 \text{ mm}$$



Therefore use, 350x350mm 8-16mm ϕ longitudinal bars (GRADE 40) with 10mm ϕ lateral ties space at, 1@50, 8@80mm, and Rest 180mm O.C, BOTH ENDS.

Side	h	m	With Seismic Provision, NSCP 2015 Sec 418.7.5					
H	Col mark	Vu	Vs	Smax	Seismic req	QTY	DIST	
Lo	0 - 0.05m	10.3366	(81.75)	193.57	50	1	50	Pass!
	6666666666	10.3366	(81.75)	193.57	80	8	80	Pass!
Mid	6666666666	10.3366	(81.75)	193.57	100	Rest	180	Ok!

Sx

$$V_s = (V_u / \phi) - V_c$$
$$S = A_v f_y t_d / V_s$$

First lat ties Min of 50mm from Face of Support

REINFORCED CONCRETE COLUMN

C - 2B / Column No. 2109

Design Parameters:

h = 350 mm	d' = 58 mm
b = 350 mm	Main bars = 16 mm ϕ
fc' = 21 Mpa	Mux = 4.222703 KNm
fy = 275 Mpa	Pu = 112.57105 KN
b ₁ = 0.85	Escon = 600 Mpa
Es = 200 Gpa	

Defining Condition:

$\phi = 0.65$, $\epsilon_t \leq \epsilon_{ty}$	if $f_s > f_y$, use f_y
$\phi = Val$, $\epsilon_{ty} < \epsilon_t < 0.005$	
$\phi = 0.90$, $\epsilon_t \geq 0.005$	

Val = Use 0.65 in transition Region

MAXIMUM AXIAL CAPACITY Ag = 122500 NSCP 422.4.2.2

$$P_{cn} = 0.8 [0.85 f'_c (A_g - A_s) + f_y A_s] = 2,080.20 \text{ kN}$$

$$\phi = 0.65, P_{cu} = \phi P_{cn} = 1,352.13 \text{ kN}$$

BALANCE CONDITION CAPACITY, $\phi = 0.65$

$$\epsilon_y = f_y / E_s = 0.00138$$

$$C_b = \epsilon_c d / \epsilon_c + \epsilon_y = 200.23 \text{ mm}$$

$$a_b = \beta C = 170.19 \text{ mm}$$

from strain diagram

As[fy or fs]

fs1 = 600(d-C)/C = 275.00	T1 = 110.58 KN, Tension
fs2 = 600(C-Z2)/C = -41.27	C2 = -16.59 KN, Tension
fs3 = 600(C-Z3)/C = 0.00	C3 = 0.00 KN,
fs4 = 600(C-Z4)/C = 192.47	C4 = 77.40 KN, Compression
fs5 = 600(C-Z5)/C = 426.20	C5 = 110.58 KN, Compression

$$C_c = .85 f'_c a_b = 1063.2888 \text{ KN}$$

$$[\sum F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T = 1124.1 \text{ KN}$$

$$[\sum M_T = 0], \text{ find } e = x - z, z = 117.00 \text{ mm}$$

$$P_{bnX} = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$e_b = 111.32 \text{ mm} \quad \phi P_b = 730.7 \text{ KN}$$

$$M_b = 125.13 \text{ KNm} \quad \phi M_b = 81.34 \text{ KNm}$$

ECCENTRICALLY LOADED SECTION CAPACITY, $\phi = .65$

due to applied load, ex = 37.51

$$[\sum F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T$$

$$[\sum M_T = 0], P_{bnX} = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$C = 322.41 \text{ mm} \quad a = 274.05 \text{ mm}$$

fs1 = 600(d-C)/C = -56.59	T1 = 22.75 KN, Tension
fs2 = 600(C-Z2)/C = 201.74	C2 = 81.13 KN, Compression
fs3 = 600(C-Z3)/C = 0.00	C3 = 0.00 KN,
fs4 = 600(C-Z4)/C = 346.90	C4 = 110.58 KN, Compression
fs5 = 600(C-Z5)/C = 492.06	C5 = 110.58 KN, Compression

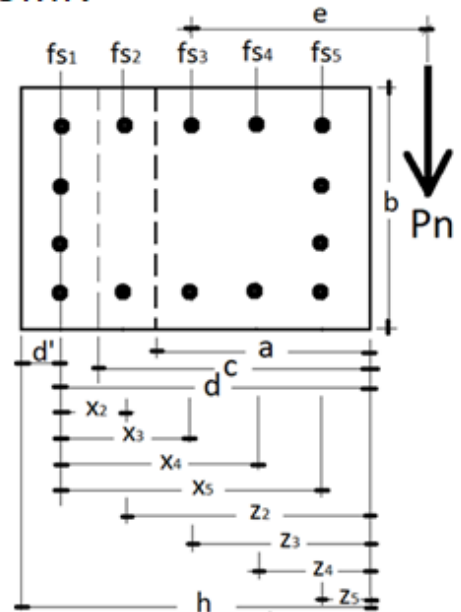
$$C_c = .85 f'_c a_b = 1712.10$$

Pnx = 2037.15	$\phi P_n = 1324.14 \text{ KN}$	>	112.57	Pass!
Mnx = 76.42	$\phi M_n = 49.67 \text{ KNm}$	>	4.22	Pass!

Main Bars	Loc-Z	Ast
fs1 = 2	-	292.00
fs2 = 2	-	214.00
fs3 = 0	-	214.00
fs4 = 2	-	136.00
fs5 = 2	-	58.00

Shear parameters

Nvh = 3	, lateral ties leg
Nvb = 3	, lateral ties leg
fyt = 230	Mpa, lateral ties
Ties, Td = 10	mm ϕ



COMPRESSION CONTROLLED CAPACITY, $\phi = .65$

$$\epsilon_t = -0.002$$

$$C_t = \epsilon_{sc} d / (\epsilon_{sc} - \epsilon_t) = 175.20 \text{ mm}$$

$$a_t = \beta C = 148.92 \text{ mm}$$

from strain diagram

As[fy or fs]

fs1 = 600(d-C)/C = 400.00	T1 = 110.58 KN, T
fs2 = 600(C-Z2)/C = -132.88	C2 = -53.43 KN, T
fs3 = 600(C-Z3)/C = 0.00	C3 = 0.00 KN,
fs4 = 600(C-Z4)/C = 134.25	C4 = 53.98 KN, C
fs5 = 600(C-Z5)/C = 401.37	C5 = 110.58 KN, C

$$C_c = .85 f'_c a_b = 930.378 \text{ KN}$$

$$[\sum F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T = 930.9 \text{ KN}$$

$$[\sum M_T = 0], \text{ find } e = x - z, z = 117 \text{ mm}$$

$$P_{bnX} = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$e_t = 100.41 \text{ mm} \quad \phi P_t = 605.10 \text{ KN}$$

$$M_t = 60.76 \text{ KNm} \quad \phi M_t = 39.49 \text{ KNm}$$

CHECK SHEAR, $\phi_v = 0.75$

$$V_c = 0.17 [1 + (P_u / 14 A_g)] \sqrt{f'_c} b d t = 84.84 \text{ KN}$$

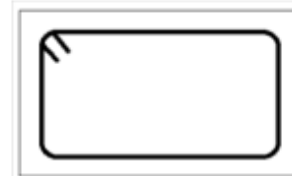
$$A_v = \pi T d^2 N_v / 4 = 235.6 \text{ mm}^2$$

Smax, min (16db, 48dties and least col dimension)

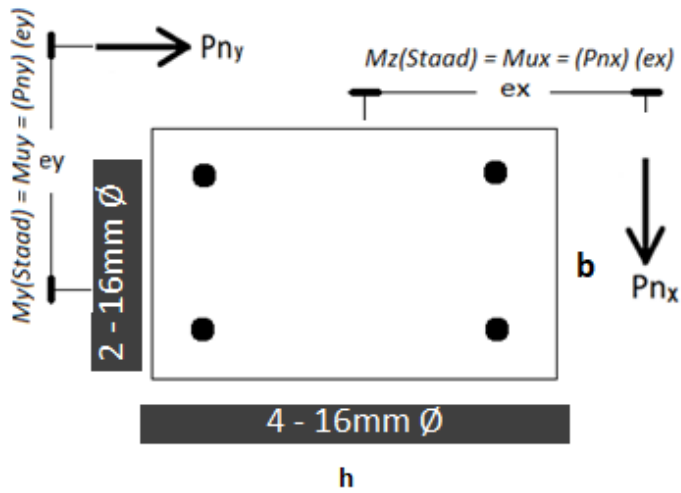
$$16 \text{ db} = 256 \text{ mm}$$

$$48 \text{ dties} = 480 \text{ mm}$$

$$\text{Least Column dimension} = 350 \text{ mm}$$



Therefore use, 350x350mm 8-16mm ϕ longitudinal bars (GRADE 40) with 10mm ϕ lateral ties space at, 1@50, 8@80mm, and Rest 180mm O.C, BOTH ENDS.



FORCE TRANSFER GUIDE FROM STAAD RESULT OR EQUIVALENT SOFTWARE

$M_z(\text{Staad}) = M_{ux} = 4.2227 < 49.67$ Pass! , $e_x = 37.51 \text{ mm}$
 $M_y(\text{Staad}) = M_{uy} = 21.1402 < 123.08$ Pass! , $e_y = 187.79 \text{ mm}$
 $\phi P_{nx} = 1324.14 > 112.57105255127$ Pass!
 $\phi P_{ny} = 655.4 > 112.57105255127$ Pass!

Col Height, $H = 3$ Floor to Beam Bottom
 Length factor, $K = 0.5$ Refer (Sheet 2)

Column Slenderness (Unbraced Column, $KL/r \leq 22$), 406.2.5

$KL/r_x = 14.29 < 22$ Ok!
 $KL/r_y = 14.29 < 22$ Ok!

Dimension Limits, 418.7.2.1

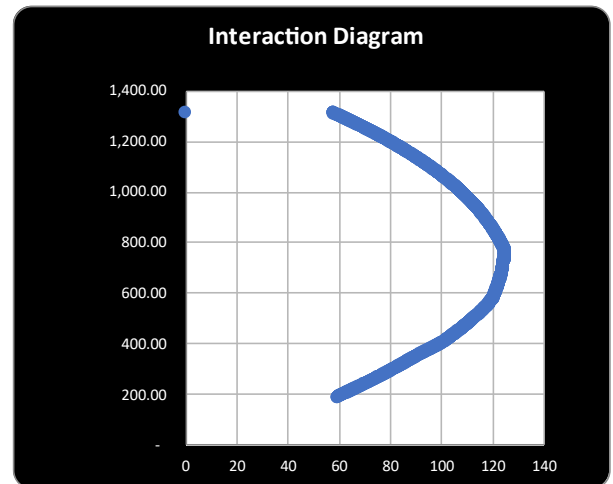
250 mm ∇ 350 Ok!

Main reinforcement Ratio $A_{st} = 1608.5$

$0.01A_g < A_{st} > 0.06A_g$ Ok!

Traverse Reinforcements, 418.7.5.4

No of Leg Req, $h = 3$ Ok! Apply on Lo and Joints only
 No of Leg Req, $b = 3$ Ok! Apply on Lo and Joints only



1

Side	h	m	With Seismic Provision, NSCP 2015 Sec 418.7.5				
H	Col mark	Vu	Vs	Smax	Seismic req	QTY	DIST
Lo	0 - 0.05m	1.30046	(83.11)	190.40	50	1	50 Pass!
	0.05 - 0.5m	1.30046	(83.11)	190.40	80	8	80 Pass!
Mid	> 0.5m	1.30046	(83.11)	190.40	100	Rest	180 Ok! Sx
$V_s = (V_u / \phi) - V_c$			First lat ties Min of 50mm from Face of Support				
$S = A_v f_y t d / V_s$							

REINFORCED CONCRETE COLUMN

C - 3 / Column No. 1110

Design Parameters:

h =	400	mm	d' =	58	mm
b =	250	mm	Main bars =	16	mm Ø
fc' =	21	Mpa	Mux =	102.55835	KNm
fy =	275	Mpa	Pu =	267.65125	KN
b ₁ =	0.85		Escon =	600	Mpa
Es =	200	Gpa			

Defining Condition:

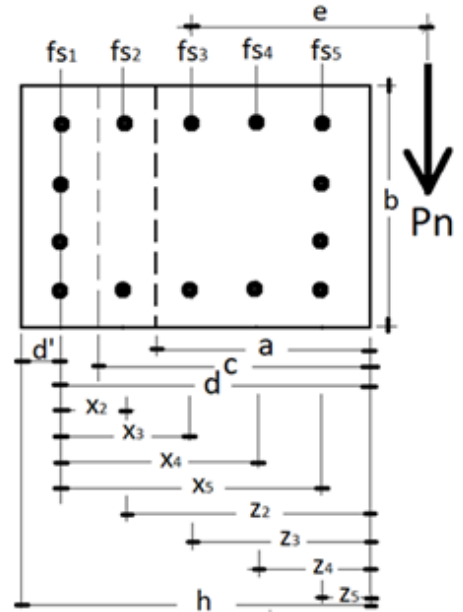
0.65	, Et ≤ Et _y	if fs > fy, use fy
Val	, Et _y < Et < 0.005	
0.90	, Et ≥ 0.005	

Val = Use 0.65 in transition Region

Main Bars	Loc-Z	Ast
fs1 = 3	-	342.00
fs2 = 2	-	271.00
fs3 = 2	-	200.00
fs4 = 2	-	129.00
fs5 = 3	-	603.19

Shear parameters

Nvh =	3	, lateral ties leg
Nvb =	3	, lateral ties leg
fy _t =	230	Mpa, lateral ties
Ties, Td =	10	mm Ø



MAXIMUM AXIAL CAPACITY Ag = 100000 NSCP 422.4.2.2

$$P_{cn} = 0.8 [0.85 f_c' (A_g - A_s) + f_y A_s] = 1,924.35 \text{ kN}$$

$$\phi = 0.65, P_{cu} = \phi P_{cn} = 1,250.83 \text{ kN}$$

BALANCE CONDITION CAPACITY, $\phi = 0.65$

$$\epsilon_y = f_y / E_s = 0.00138$$

$$C_b = \epsilon_c d / \epsilon_c + \epsilon_y = 234.51 \text{ mm}$$

$$a_b = \beta C = 199.34 \text{ mm}$$

from strain diagram

As[fy or fs]

fs1 = 600(d-C)/C =	275.00	T1 = 165.88	KN, Tension
fs2 = 600(C-Z2)/C =	-93.35	C2 = -37.54	KN, Tension
fs3 = 600(C-Z3)/C =	88.30	C3 = 35.51	KN, Compression
fs4 = 600(C-Z4)/C =	269.96	C4 = 108.56	KN, Compression
fs5 = 600(C-Z5)/C =	451.61	C5 = 165.88	KN, Compression

$$C_c = .85 f_c' a_b = 889.542 \text{ KN}$$

$$[\sum F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T = 996.1 \text{ KN}$$

$$[\sum M_T = 0], \text{ find } e = x - z, z = 142.00 \text{ mm}$$

$$P_{bnX} = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$e_b = 147.31 \text{ mm} \quad \phi P_b = 647.4 \text{ KN}$$

$$M_b = 146.73 \text{ KNm} \quad \phi M_b = 95.37 \text{ KNm}$$

ECCENTRICALLY LOADED SECTION CAPACITY, $\phi = .90$

due to applied load, ex = 383.18

$$[\sum F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T$$

$$[\sum M_T = 0], P_{bnX} = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$C = 140.76 \text{ mm} \quad a = 119.65 \text{ mm}$$

fs1 = 600(d-C)/C =	857.76	T1 = 165.88	KN, Tension
fs2 = 600(C-Z2)/C =	-555.12	C2 = 110.58	KN, Tension
fs3 = 600(C-Z3)/C =	-252.49	C3 = 101.53	KN, Tension
fs4 = 600(C-Z4)/C =	50.14	C4 = 20.16	KN, Compression
fs5 = 600(C-Z5)/C =	352.78	C5 = 165.88	KN, Compression

$$C_c = .85 f_c' a_b = 533.94$$

Pnx =	341.98	φPn =	307.78	KN	>	267.65	Pass!
Mnx =	131.04	φMn =	117.94	KNm	>	102.56	Pass!

TENSION CONTROLLED CAPACITY,

$\phi = .90$

$$\epsilon_t = -0.005$$

$$C_t = \epsilon_{scon} d / (\epsilon_{scon} - \epsilon_t) = 128.25 \text{ mm}$$

$$a_t = \beta C = 109.01 \text{ mm}$$

from strain diagram

As[fy or fs]

fs1 = 600(d-C)/C =	1000.00	T1 = 165.88	KN, T
fs2 = 600(C-Z2)/C =	-667.84	C2 = -110.58	KN, T
fs3 = 600(C-Z3)/C =	-335.67	C3 = -110.58	KN, T
fs4 = 600(C-Z4)/C =	-3.51	C4 = -1.41	KN, T
fs5 = 600(C-Z5)/C =	328.65	C5 = 165.88	KN, C

$$C_c = .85 f_c' a_b = 486.468 \text{ KN}$$

$$[\sum F_v = 0], P_{bn} = C_2 + C_3 + C_4 + C_5 + C_c - T = 263.9 \text{ KN}$$

$$[\sum M_T = 0], \text{ find } e = x - z, z = 142 \text{ mm}$$

$$P_{bnX} = C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5 + C_c X_c$$

$$e_t = 387.98 \text{ mm} \quad \phi P_t = 237.50 \text{ KN}$$

$$M_t = 92.15 \text{ KNm} \quad \phi M_t = 82.93 \text{ KNm}$$

CHECK SHEAR, $\phi_v = 0.75$

$$V_c = 0.17 [1 + (P_u / 14 A_g)] \sqrt{f_c'} b d t = 79.34 \text{ KN}$$

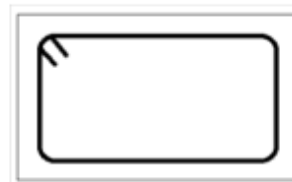
$$A_v = \pi T d^2 N_v / 4 = 235.6 \text{ mm}^2$$

Smax, min (16db, 48dties and least col dimension)

$$16 \text{ db} = 256 \text{ mm}$$

$$48 \text{ dties} = 480 \text{ mm}$$

$$\text{Least Column dimension} = 250 \text{ mm}$$



Therefore use, 400x250mm 12-16mm Ø longitudinal bars (GRADE 40) with 10mm Ø lateral ties space at, 1@50, 8@60mm, and Rest 180mm O.C, BOTH ENDS.

BEAMS

PROPOSED TWO STOREY COMMERCIAL BUILDING

REINFORCED CONCRETE BEAM

B - 1 / Beam No. 12106

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot
$f_c' = 21$	ion Bar, Dt =	4	4
$f_y = 275$	Bar 2-L, Nb =	3	3
$b_1 = .85$	ion Bar, Dc =	4	4
$E_s = 200$ Gpa	Main Bar dia, D =	20	
	Moment, Mu =	172.2	2.2

Shear Capacity	
$b_w = 250$ mm	$f_y = 230$
$h = 500$ mm	$A_v = 2$
$S_b = 10$ mm	Stirrups Bar \emptyset
$C_c = 40$ mm	Clear Covering

CONDITION : $\lambda = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$\phi = 0.65$, $\epsilon_t \leq \epsilon_{ty}$

$\lambda = 0.90$, $\epsilon_t < \epsilon_{ty} < 0.005$

$\lambda = 0.90$, $\epsilon_t \geq 0.005$

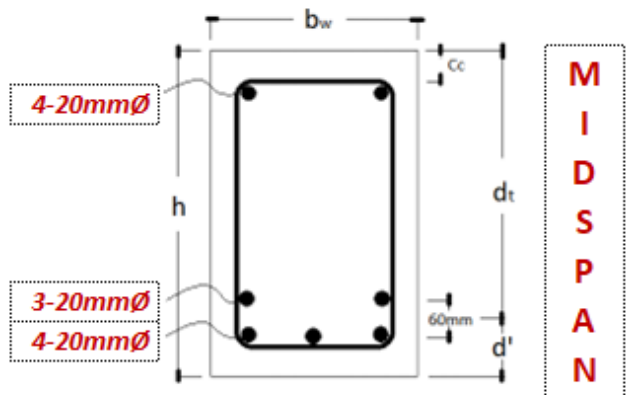
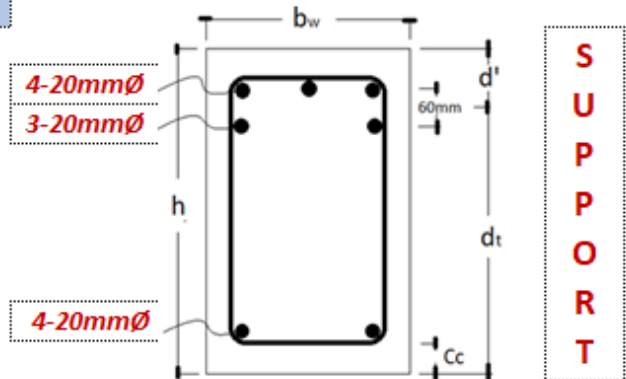
Location of d' & dt;	Support	Midspan
$A_{s1} = \pi D^2 D_b / 4 =$	1256.64	1256.64
$2L, A_{s2} = \pi D^2 N_b / 4 =$	942.48	942.48
$y = (A_{s1} y_1 + A_{s2} y_2) / A_s =$	25.71	25.71
$d' = C_c + S_b + (D/2) + y =$	85.71	85.71
$dt = h - d' =$	414.29	414.29

CHECKING :	Support	Midspan
$C_{max} = 600 dt / f_{smin} + 600 =$	177.6	177.55
$a_{max} = \beta_1 C_{max} =$	150.9	150.92
$A_{smax} = 0.85 f_c' a_{max} b_w / f_y =$	2448.99	2448.99
$a = (A_s f_y - A_s' f_y) / 0.85 f_c' b =$	135.52	135.52
$C = a / \beta_1 =$	159.43	159.43
$f_s' = 600 (C - d') / C =$	277.43	277.43
$f_s' = \text{Compression Bars} =$	Yield	Yield
$f_s = 600 (dt - C) / C =$	959.08	959.08
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$A_s f_y = \lambda 85 f_c' \beta_1 C b_w + A_s' f_s'$ Where, $f_s' = (600 C - d') / C$

	Support	Midspan
$C = \text{by quadratic} =$	112.24	112.24
$a = \beta_1 C =$	95.40	95.40
$f_s' = 600 (C - d') / C =$	141.78	141.78
$f_s = 600 (dt - C) / C =$	1614.73	1614.73
$M_n = \lambda [d t - (a/2)] + C_s (dt - d') =$	214.60	214.60
SUPPORT, $\phi M_n =$	193.14	> 172.23
MIDSPAN, $\phi M_n =$	193.14	> 2.16

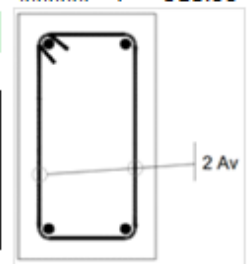


CHECK SHEAR; $\phi = 0.75$

$V_c = 0.17 v f_c' b_w dt =$	81	< 158.61
$V_{smax} = 0.67 v f_c' b_w dt =$	318	KN
$V_s = (V_u / \phi) - V_c =$	#####	< 318.00

Section is Adequate

$A_v = 2 (\pi S_b^2 / 4) =$	157.1
$V_s \leq 0.33 v f_c' b_w d, d/2$	
or 600mm otherwise	
$V_s > 0.33 v f_c' b_w d,$	
or 300mm	



Therefore use 250x500 with 11-20mm \emptyset @ support and 11-20mm \emptyset @ midspan Main Bars (Grade 40);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 6@100 and rest 150 O.C

Main Bar Spacing Calculator

Sup Main Bar, S = 30 > 25mm

Mid Main Bar, S = 30 > 25mm

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

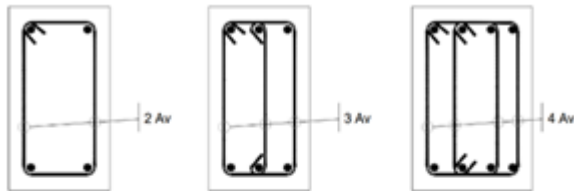
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	158.61	130.80	127.1	50.00	1.00	50.00	Pass!
2h	0.05 - 1m	158.17	130.21	127.6	103.57	6.00	100.00	Pass!
> 2h	> 1m	141.64	108.17	153.6	127.06	Rest	150.00	Pass!

REINFORCED CONCRETE BEAM

B - 2 / Beam No. 12129

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, Dt =	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 415$	Bar 2-L, Nb =	2	2	$h = 500$ mm $A_v = 2$
$b_1 = .85$	ion Bar, Dc =	3	3	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, D =	20		$C_c = 40$ mm, Clear Covering
	Moment, Mu =	173.6	10.7	

CONDITION : $\text{Val} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\emptyset = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$\text{Val}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & dt ;

	Support	Midspan
$As1 = \pi D^2 Db / 4 =$	942.48	942.48
$2L, As2 = \pi D^2 Nb / 4 =$	628.32	628.32
$y = (As1 y1 + As2 y2) / As =$	24.00	24.00
$d' = C_c + S_b + (D/2) + y =$	84.00	84.00
$dt = h - d' =$	416.00	416.00

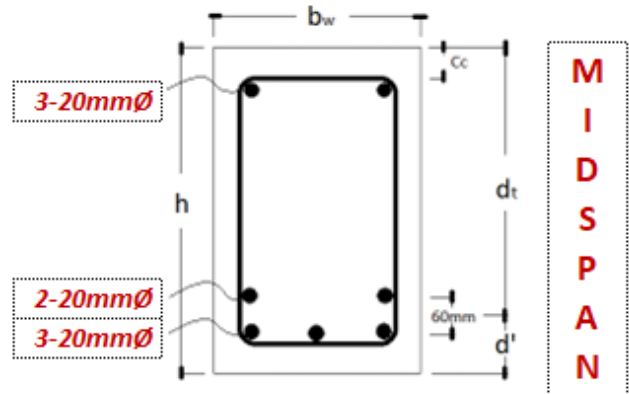
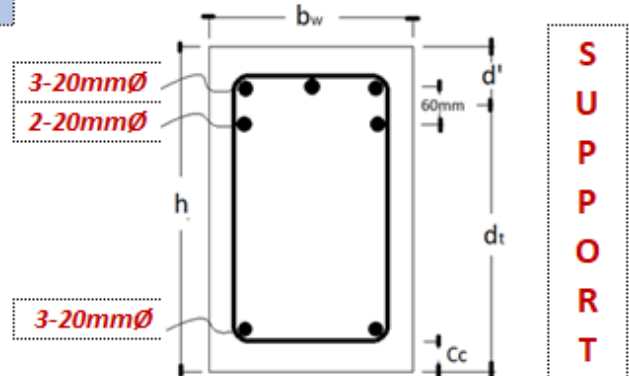
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 dt / f_{smin} + 600 =$	178.3	178.29
$a_{max} = \beta_1 C_{max} =$	151.5	151.54
$As_{max} = 0.85 f_c' a_{max} b_w / f_y =$	1303.63	1303.63
$a = (As f_y - As' f_y) / 0.85 f_c' b =$	73.04	73.04
$C = a / \beta_1 =$	85.93	85.93
$f_s' = 600 (C - d') / C =$	13.47	13.47
$f_s' = \text{Compression Bars} =$	Not Yield	Not Yield
$f_s = 600 (dt - C) / C =$	2304.72	2304.72
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\emptyset = 0.9$

$$As f_y = 1.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic} =$	140.15	140.15
$a = \beta_1 C =$	119.13	119.13
$f_s' = 600 (C - d') / C =$	240.39	240.39
$f_s = 600 (dt - C) / C =$	1180.92	1180.92
$M_n = [c d t - (a/2)] + C_s (d t - d' =$	226.81	226.81
SUPPORT, $\emptyset M_n =$	204.13	> 173.62 Pass!
MIDSPAN, $\emptyset M_n =$	204.13	> 10.70 Pass!

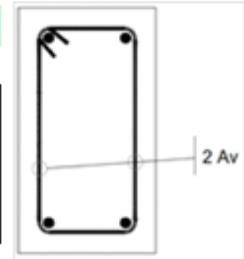


CHECK SHEAR; $\emptyset = 0.75$

$V_c = 0.17 \sqrt{f_c'} b_w dt =$	65	< 136.30
$V_{smax} = 0.67 \sqrt{f_c'} b_w dt =$	255	KN
$V_s = (V_u / \emptyset) - V_c =$	#####	< 255.45

Section is Adequate

$A_v = 2 (\pi S_b^2 / 4) =$	157.1
$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$	
or 600mm otherwise	
$V_s > 0.33 \sqrt{f_c'} b_w d,$	
or 300mm	



Therefore use 200x500 with 8-20mm \emptyset @ support and 8-20mm \emptyset @ midspan Main Bars (Grade 60);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 6@100 and rest 150 O.C

Main Bar Spacing Calculator

Sup Main Bar, $S = 30 > 25\text{mm}$

Mid Main Bar, $S = 30 > 25\text{mm}$

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

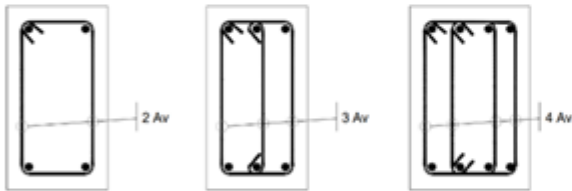
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	136.30	116.91	142.2	50.00	1.00	50.00	Pass!
2h	0.05 - 1m	135.45	115.79	143.5	104.00	6.00	100.00	Pass!
> 2h	> 1m	116.95	91.12	182.4	142.15	Rest	150.00	Pass!

REINFORCED CONCRETE BEAM

B - 3 / Beam No. 12127

Input Parameters :

Standard Specs

$$f_c' = 21$$

$$f_y = 275$$

$$b_1 = .85$$

$$E_s = 200 \text{ Gpa}$$

Momen

$$\text{ion Bar, } D_t =$$

$$\text{Bar 2-L, } N_b =$$

$$\text{ion Bar, } D_c =$$

$$\text{Main Bar dia, } D =$$

$$\text{Moment, } M_u =$$

Sup	Mid
Top	Bot
2	2
2	0
3	4
20	
102.1	3.9

Shear Capacity

$$b_w = 200 \text{ mm } f_{yt} = 230$$

$$h = 500 \text{ mm } A_v = 2$$

$$S_b = 10 \text{ mm } \text{Stirrups Bar } \emptyset$$

$$C_c = 40 \text{ mm, Clear Covering}$$

CONDITION : $Val = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\emptyset = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$Val, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & dt ;

	Support	Midspan
$As1 = \pi D^2 Db / 4$	628.32	628.32
$2L, As2 = \pi D^2 Nb / 4$	628.32	0.00
$y = (As1 y1 + As2 y2) / As$	30.00	0.00
$d' = C_c + S_b + (D/2) + y$	90.00	60.00
$dt = h - d'$	410.00	440.00

CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 dt / f_{smin} + 600$	175.7	188.57
$a_{max} = \beta_1 C_{max}$	149.4	160.29
$As_{max} = 0.85 f_c' a_{max} b_w / f_y$	1938.93	2080.80
$a = (As f_y - As' f_y) / 0.85 f_c' b$	96.80	48.40
$C = a / \beta_1$	113.88	56.94
$f_s' = 600 (C - d') / C$	125.83	-348.35
$f_s' = \text{Compression Bars}$	Not Yield	Not Yield
$f_s = 600 (dt - C) / C$	1560.13	4036.37
$f_s = \text{Tension Bars}$	Yield	Yield

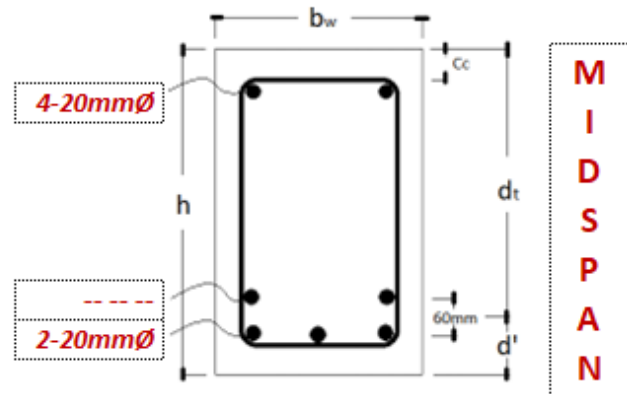
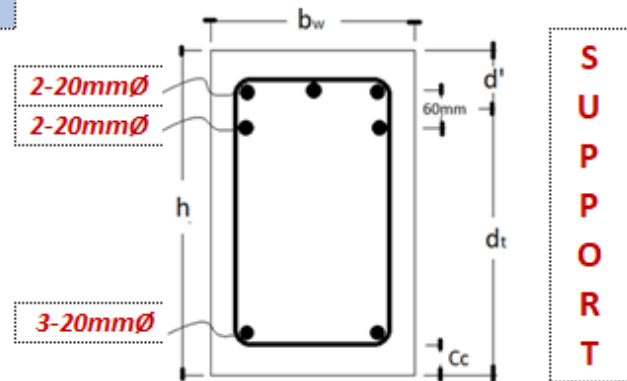
BEAM MOMENT CAPACITY $\emptyset = 0.9$

$$As f_y = 0.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic}$	98.17	59.30
$a = \beta_1 C$	83.44	50.40
$f_s' = 600 (C - d') / C$	49.93	-7.08
$f_s = 600 (dt - C) / C$	1905.86	3851.94
$M_n = \phi [d t - (a/2)] + C_s (d t - d' =$	127.59	71.26

$$\text{SUPPORT, } \emptyset M_n = 114.83 > 102.10 \text{ Pass!}$$

$$\text{MIDSPAN, } \emptyset M_n = 64.13 > 3.89 \text{ Pass!}$$



CHECK SHEAR; $\emptyset = 0.75$

$$V_c = 0.17 v_{fc}' b_w dt = 64 < 135.48$$

$$V_{smax} = 0.67 v_{fc}' b_w dt = 252 \text{ KN}$$

$$V_s = (V_u / \emptyset) - V_c = \text{#####} < 251.77$$

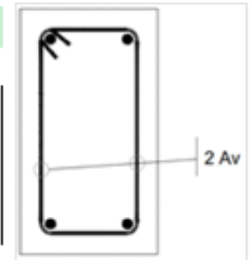
Section is Adequate

$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$\text{Max } S, \text{ w/c ever is lesser, mm}$$

$$Vs \leq 0.33 v_{fc}' b_w d, d/2 \text{ or } 600 \text{ mm otherwise}$$

$$Vs > 0.33 v_{fc}' b_w d, \text{ or } 300 \text{ mm}$$



Therefore use 200x500 with 7-20mmØ @ support and 6-20mmØ @ midspan Main Bars (Grade 40);

10mmØ 2 leg-stirrups: Sp. at 1@50, 6@100 and rest 150 O.C

Main Bar Spacing Calculator

Sup Main Bar, $S = 80 > 25\text{mm}$

Mid Main Bar, $S = 80 > 25\text{mm}$

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

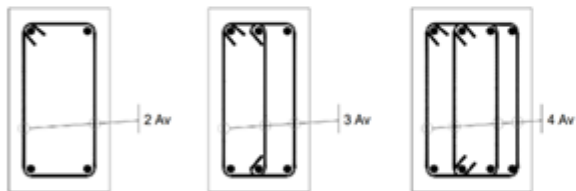
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	135.48	116.76	142.3	50.00	1.00	50.00	Pass!
2h	0.05 - 1m	134.64	115.64	143.7	102.50	6.00	100.00	Pass!
> 2h	> 1m	117.98	93.42	177.9	142.33	Rest	150.00	Pass!

REINFORCED CONCRETE BEAM

B - 4 / Beam No. 12121

Input Parameters :

Standard Specs

$$f_c' = 21$$

$$f_y = 415$$

$$b_1 = .85$$

$$E_s = 200 \text{ Gpa}$$

Momen

$$\text{ion Bar, } D_t =$$

$$\text{Bar 2-L, } N_b =$$

$$\text{ion Bar, } D_c =$$

$$\text{Main Bar dia, } D =$$

$$\text{Moment, } M_u =$$

Sup	Mid
Top	Bot
3	3
3	3
3	4
20	20
193.4	18.8

Shear Capacity

$$b_w = 200 \text{ mm } f_{yt} = 230$$

$$h = 500 \text{ mm } A_v = 2$$

$$S_b = 10 \text{ mm } \text{Stirrups Bar } \emptyset$$

$$C_c = 40 \text{ mm, Clear Covering}$$

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\emptyset = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t :

Support Midspan

$$A_{s1} = \pi D^2 D_b / 4 = 942.48 \quad 942.48$$

$$2L, A_{s2} = \pi D^2 N_b / 4 = 942.48 \quad 942.48$$

$$y = (A_{s1} y_1 + A_{s2} y_2) / A_s = 30.00 \quad 30.00$$

$$d' = C_c + S_b + (D/2) + y = 90.00 \quad 90.00$$

$$d_t = h - d' = 410.00 \quad 410.00$$

CHECKING : $\epsilon_t \geq 0.004$,

Support Midspan

$$C_{max} = 600 d_t / f_{smin} + 600 = 175.7 \quad 175.71$$

$$a_{max} = \beta_1 C_{max} = 149.4 \quad 149.36$$

$$A_{smax} = 0.85 f_c' a_{max} b_w / f_y = 1284.83 \quad 1284.83$$

$$a = (A_s f_y - A_s' f_y) / 0.85 f_c' b = 109.56 \quad 73.04$$

$$C = a / \beta_1 = 128.89 \quad 85.93$$

$$f_s' = 600 (C - d') / C = 181.05 \quad -28.42$$

$$f_s' = \text{Compression Bars} = \text{Not Yield} \quad \text{Not Yield}$$

$$f_s = 600 (d_t - C) / C = 1308.55 \quad 2262.82$$

$$f_s = \text{Tension Bars} = \text{Yield} \quad \text{Yield}$$

BEAM MOMENT CAPACITY $\emptyset = 0.9$

$$A_s f_y = 1.85 f_c' \beta_1 C b_w + A_s' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

Support Midspan

$$C = \text{by quadratic} = 170.13 \quad 154.34$$

$$a = \beta_1 C = 144.61 \quad 131.19$$

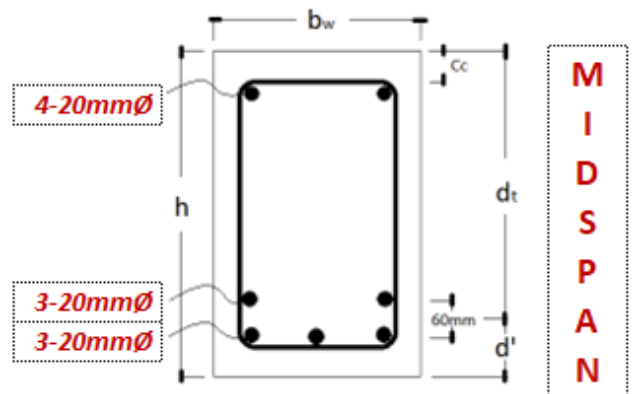
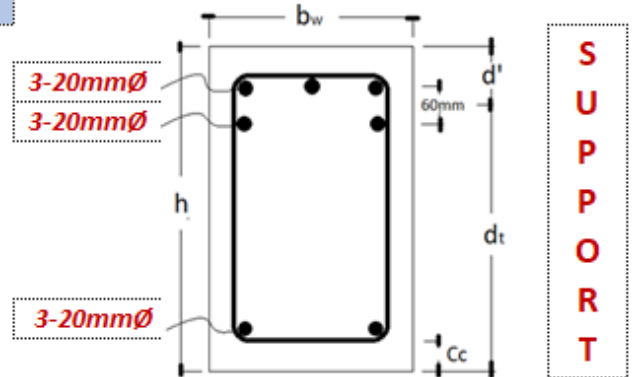
$$f_s' = 600 (C - d') / C = 282.59 \quad 250.12$$

$$f_s = 600 (d_t - C) / C = 846.00 \quad 993.88$$

$$M_n = \phi [d_t (a/2)] + C_s (d_t - d') = 259.56 \quad 261.88$$

$$\text{SUPPORT, } \emptyset M_n = 233.60 > 193.39 \quad \text{Pass!}$$

$$\text{MIDSPAN, } \emptyset M_n = 235.69 > 18.80 \quad \text{Pass!}$$



CHECK SHEAR; $\emptyset = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 64 < 149.18$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 252 \text{ KN}$$

$$V_s = (V_u / \emptyset) - V_c = \text{#####} < 251.77$$

Section is Adequate

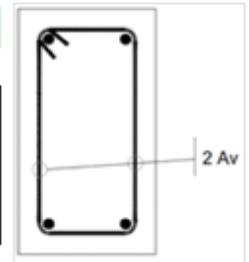
$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$\text{Max } S, \text{ w/c ever is lesser, mm}$$

$$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$$

$$\text{or } 600 \text{ mm otherwise}$$

$$V_s > 0.33 \sqrt{f_c'} b_w d, \text{ or } 300 \text{ mm}$$



Therefore use 200x500 with 3-20mm \emptyset @ support and 4-20mm \emptyset @ midspan Main Bars (Grade 60);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 6@100 and rest 150 O.C

Main Bar Spacing Calculator

Sup Main Bar, $S = 30 > 25\text{mm}$

Mid Main Bar, $S = 30 > 25\text{mm}$

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

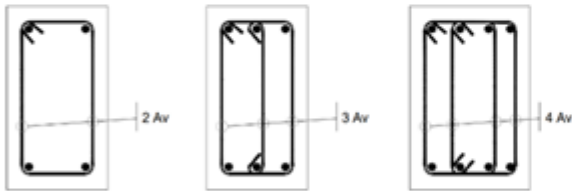
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	149.18	135.03	123.1	50.00	1.00	50.00	Pass!
2h	0.05 - 1m	148.21	133.74	124.3	102.50	6.00	100.00	Pass!
> 2h	> 1m	123.37	100.61	165.2	123.08	Rest	150.00	Pass!

REINFORCED CONCRETE BEAM

RB - 1 / Beam No. 22106

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, $D_t =$	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 275$	Bar 2-L, $N_b =$	0	0	$h = 450$ mm $A_v = 2$
$b_1 = .85$	ion Bar, $D_c =$	4	4	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, $D =$	16		$C_c = 40$ mm, Clear Covering
	Moment, $M_u =$	40.9	29.3	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t ;

	Support	Midspan
$As_1 = \pi D^2 Db / 4 =$	603.19	603.19
$2L, As_2 = \pi D^2 Nb / 4 =$	0.00	0.00
$y = (As_1 y_1 + As_2 y_2) / As =$	0.00	0.00
$d' = C_c + S_b + (D/2) + y =$	58.00	58.00
$d_t = h - d' =$	392.00	392.00

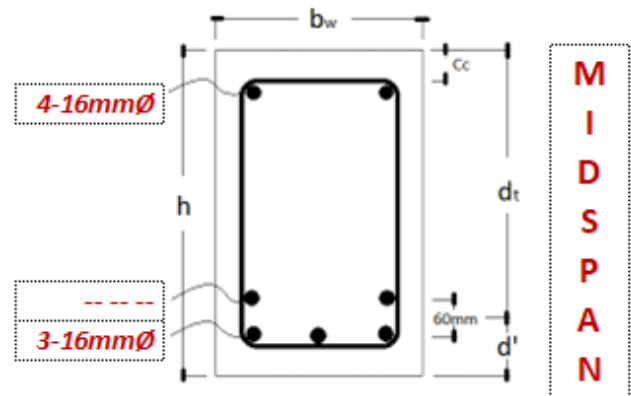
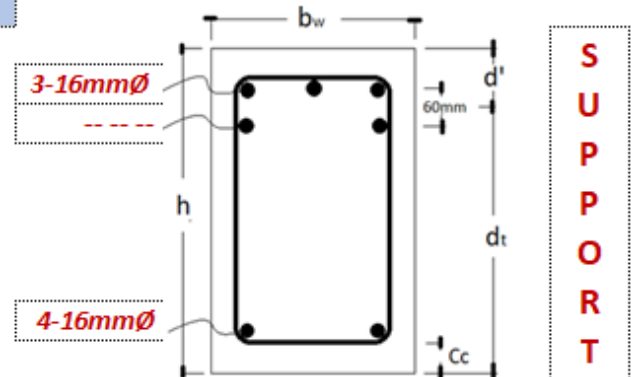
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 d_t / f_{smin} + 600 =$	168.0	168.00
$a_{max} = \beta_1 C_{max} =$	142.8	142.80
$As_{max} = 0.85 f_c' a_{max} b_w / f_y =$	1853.80	1853.80
$a = (As f_y - As' f_y) / 0.85 f_c' b =$	46.46	46.46
$C = a / \beta_1 =$	54.66	54.66
$f_s' = 600 (C - d') / C =$	-36.62	-36.62
$f_s' = \text{Compression Bars} =$	Not Yield	Not Yield
$f_s = 600 (d_t - C) / C =$	3702.70	3702.70
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$As f_y = 1.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic} =$	57.06	57.06
$a = \beta_1 C =$	48.50	48.50
$f_s' = 600 (C - d') / C =$	-9.93	-9.93
$f_s = 600 (d_t - C) / C =$	3522.27	3522.27
$M_n = c [d t - (a/2)] + C_s (d t - d') =$	61.00	61.00
SUPPORT, $\phi M_n =$	54.90	> 40.91 Pass!
MIDSPAN, $\phi M_n =$	54.90	> 29.30 Pass!



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 61 < 34.63$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 241 \text{ KN}$$

$$V_s = (V_u / \phi) - V_c = (14.91) < 240.71$$

Section is Adequate

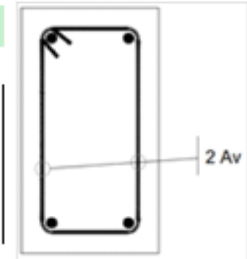
$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$$

$$\text{or } 600 \text{ mm otherwise}$$

$$V_s > 0.33 \sqrt{f_c'} b_w d,$$

$$\text{or } 300 \text{ mm}$$



Therefore use 200x450 with 7-16mm \emptyset @ support and 7-16mm \emptyset @ midspan Main Bars (Grade 40);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 5@90 and rest 200 O.C

Main Bar Spacing Calculator

Sup Main Bar, S = 36 > 25mm

Mid Main Bar, S = 36 > 25mm

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

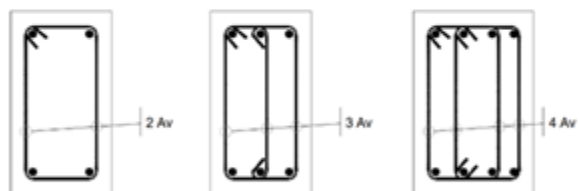
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Ok!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	34.63	(14.91)	993.7	50.00	1.00	50.00	Pass!
2h	0.05 - 0.9m	34.48	(15.11)	980.5	96.00	5.00	90.00	Pass!
> 2h	> 0.9m	-	(61.08)	242.5	196.00	Rest	200.00	Pass!

REINFORCED CONCRETE BEAM

RB - 2 / Beam No. 22124

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, $D_t =$	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 275$	Bar 2-L, $N_b =$	3	0	$h = 500$ mm $A_v = 2$
$b_1 = .85$	ion Bar, $D_c =$	5	5	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, $D =$	16		$C_c = 40$ mm, Clear Covering
	Moment, $M_u =$	62.2	46.9	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t ;

	Support	Midspan
$A_{s1} = \pi D^2 D_b / 4 =$	603.19	603.19
$2L, A_{s2} = \pi D^2 N_b / 4 =$	603.19	0.00
$y = (A_{s1} y_1 + A_{s2} y_2) / A_s =$	30.00	0.00
$d' = C_c + S_b + (D/2) + y =$	88.00	58.00
$d_t = h - d' =$	412.00	442.00

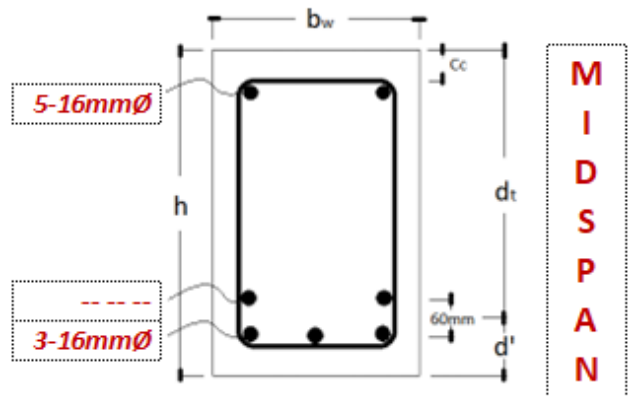
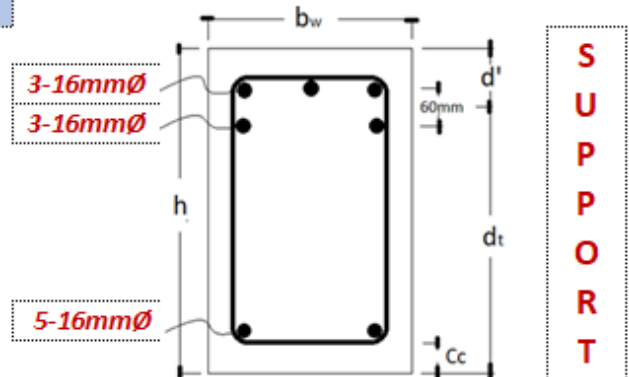
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 d_t / f_{smin} + 600 =$	176.6	189.43
$a_{max} = \beta_1 C_{max} =$	150.1	161.01
$A_{smax} = 0.85 f_c' a_{max} b_w / f_y =$	1948.39	2090.26
$a = (A_s f_y - A_s' f_y) / 0.85 f_c' b =$	92.93	46.46
$C = a / \beta_1 =$	109.33	54.66
$f_s' = 600 (C - d') / C =$	117.04	-365.91
$f_s' = \text{Compression Bars} =$	Not Yield	Not Yield
$f_s = 600 (d_t - C) / C =$	1661.11	4251.51
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$A_s f_y = 1.85 f_c' \beta_1 C b_w + A_s' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic} =$	94.94	57.35
$a = \beta_1 C =$	80.70	48.75
$f_s' = 600 (C - d') / C =$	43.84	-6.75
$f_s = 600 (d_t - C) / C =$	2003.86	4023.83
$M_n = \phi [d_t - (a/2)] + C_s (d_t - d') =$	123.99	70.08
SUPPORT, $\phi M_n =$	111.59	> 62.20 Pass!
MIDSPAN, $\phi M_n =$	63.07	> 46.93 Pass!



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 64 < 45.61$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 253 \text{ KN}$$

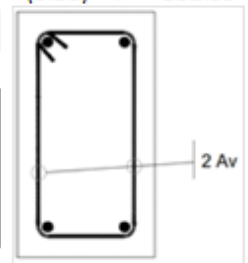
$$V_s = (V_u / \phi) - V_c = (3.38) < 252.99$$

Section is Adequate

$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2 \text{ or } 600 \text{ mm otherwise}$$

$$V_s > 0.33 \sqrt{f_c'} b_w d, \text{ or } 300 \text{ mm}$$



Therefore use 200x500 with 11-16mm \emptyset @ support and 8-16mm \emptyset @ midspan Main Bars (Grade 40);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 5@90 and rest 200 O.C

Main Bar Spacing Calculator

Sup Main Bar, $S = 36 > 25\text{mm}$

Mid Main Bar, $S = 36 > 25\text{mm}$

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

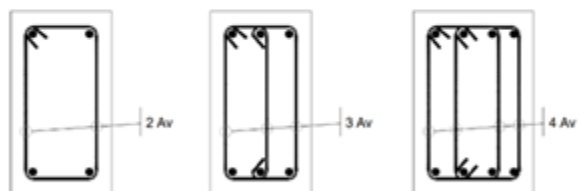
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$\rho_{min} \geq 0.25 \rho_{max}$ Ok!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	45.61	(3.38)	4,921.5	50.00	1.00	50.00	Pass!
2h	0.05 - 1m	45.44	(3.60)	4,616.6	96.00	5.00	90.00	Pass!
> 2h	> 1m	-	(64.19)	258.9	206.00	Rest	200.00	Pass!

REINFORCED CONCRETE BEAM

RB - 3 / Beam No. 22133

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, $D_t =$	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 275$	Bar 2-L, $N_b =$	3	0	$h = 400$ mm $A_v = 2$
$b_1 = .85$	ion Bar, $D_c =$	4	4	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, $D =$	16		$C_c = 40$ mm, Clear Covering
	Moment, $M_u =$	71.2	7.5	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t ;

	Support	Midspan
$A_{s1} = \pi D^2 D_b / 4 =$	603.19	603.19
$2L, A_{s2} = \pi D^2 N_b / 4 =$	603.19	0.00
$y = (A_{s1} y_1 + A_{s2} y_2) / A_s =$	30.00	0.00
$d' = C_c + S_b + (D/2) + y =$	88.00	58.00
$d_t = h - d' =$	312.00	342.00

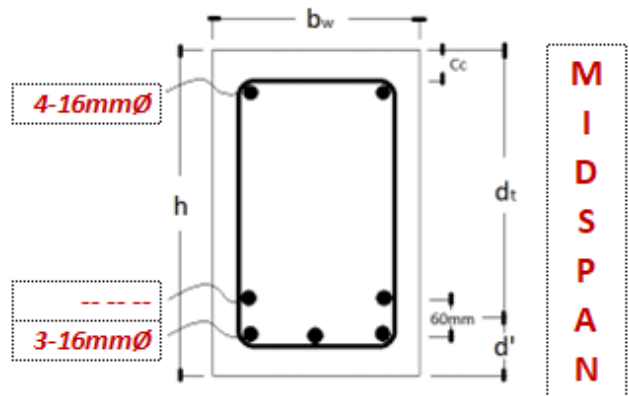
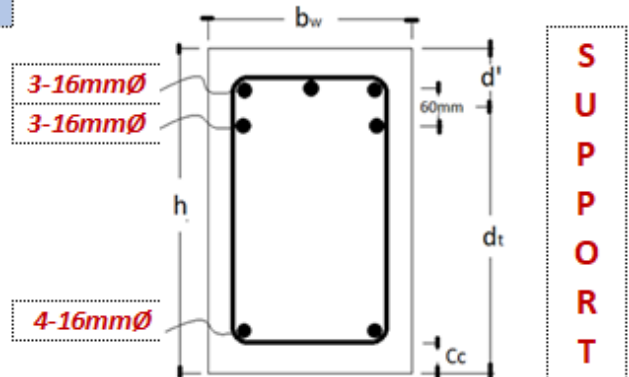
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 d_t / f_{smin} + 600 =$	133.7	146.57
$a_{max} = \beta_1 C_{max} =$	113.7	124.59
$A_{smax} = 0.85 f_c' a_{max} b_w / f_y =$	1475.48	1617.35
$a = (A_s f_y - A_s' f_y) / 0.85 f_c' b =$	92.93	46.46
$C = a / \beta_1 =$	109.33	54.66
$f_s' = 600 (C - d') / C =$	117.04	-365.91
$f_s' = \text{Compression Bars} =$	Not Yield	Not Yield
$f_s = 600 (d_t - C) / C =$	1112.30	3153.88
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$A_s f_y = 1.85 f_c' \beta_1 C b_w + A_s' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic} =$	96.00	57.09
$a = \beta_1 C =$	81.60	48.52
$f_s' = 600 (C - d') / C =$	50.02	-9.59
$f_s = 600 (d_t - C) / C =$	1349.92	2994.45
$M_n = \phi [d_t (a/2)] + C_s (d_t - d') =$	90.43	52.85
SUPPORT, $\phi M_n =$	81.39	> 71.19 Pass!
MIDSPAN, $\phi M_n =$	47.57	> 7.49 Pass!



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 49 < 58.64$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 192 \text{ KN}$$

$$V_s = (V_u / \phi) - V_c = 29.57 < 191.59$$

Section is Adequate

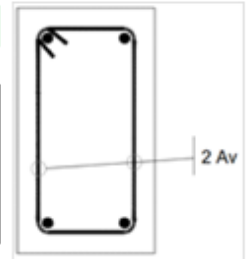
$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$$

$$\text{or } 600 \text{ mm otherwise}$$

$$V_s > 0.33 \sqrt{f_c'} b_w d,$$

$$\text{or } 300 \text{ mm}$$



Therefore use 200x400 with 10-16mm \emptyset @ support and 7-16mm \emptyset @ midspan Main Bars (Grade 40);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 5@70 and rest 200 O.C

Main Bar Spacing Calculator

Sup Main Bar, S = 36 > 25mm
Mid Main Bar, S = 36 > 25mm

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!
 $A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	58.64	29.57	439.8	50.00	1.00	50.00	Pass!
2h	0.05 - 0.8m	57.86	28.53	455.9	78.00	5.00	70.00	Pass!
> 2h	> 0.8m	45.90	12.59	1,033.1	156.00	Rest	200.00	Pass!

REINFORCED CONCRETE BEAM

RB - 4 / Beam No. 22137

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, Dt =	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 275$	Bar 2-L, Nb =	2	0	$h = 450$ mm $A_v = 2$
$b_1 = .85$	ion Bar, Dc =	4	6	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, D =	20		$C_c = 40$ mm, Clear Covering
	Moment, Mu =	102.8	24.0	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\emptyset = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & dt ;

	Support	Midspan
$As1 = \pi D^2 Db / 4$	= 942.48	942.48
$2L, As2 = \pi D^2 Nb / 4$	= 628.32	0.00
$y = (As1 y1 + As2 y2) / As$	= 24.00	0.00
$d' = C_c + S_b + (D/2) + y$	= 84.00	60.00
$dt = h - d'$	= 366.00	390.00

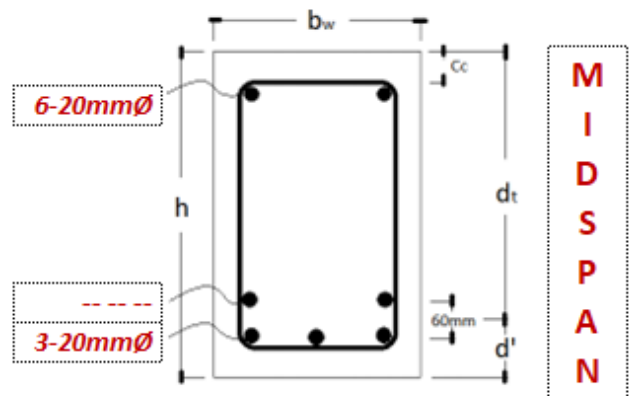
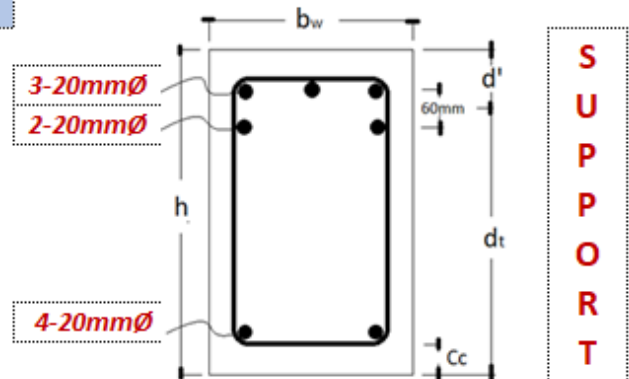
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 dt / f_{smin} + 600$	= 156.9	167.14
$a_{max} = \beta_1 C_{max}$	= 133.3	142.07
$As_{max} = 0.85 f_c' a_{max} b_w / f_y$	= 1730.85	1844.35
$a = (As f_y - As' f_y) / 0.85 f_c' b$	= 121.00	72.60
$C = a / \beta_1$	= 142.35	85.41
$f_s' = 600 (C - d') / C$	= 245.95	9.92
$f_s' = \text{Compression Bars}$	= Not Yield	= Not Yield
$f_s = 600 (dt - C) / C$	= 942.65	2139.68
$f_s = \text{Tension Bars}$	= Yield	= Yield

BEAM MOMENT CAPACITY $\emptyset = 0.9$

$$As f_y = 1.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic}$	= 100.92	63.79
$a = \beta_1 C$	= 85.78	54.22
$f_s' = 600 (C - d') / C$	= 100.58	35.65
$f_s = 600 (dt - C) / C$	= 1576.02	3068.29
$M_n = \phi [d t - (a/2)] + C_s (d t - d')$	= 140.66	92.42
SUPPORT, $\emptyset M_n$	= 126.59	> 102.77
MIDSPAN, $\emptyset M_n$	= 83.18	> 23.97

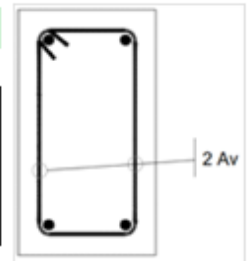


CHECK SHEAR; $\emptyset = 0.75$

$V_c = 0.17 \sqrt{f_c'} b_w dt$	=	57	<	61.87
$V_{smax} = 0.67 \sqrt{f_c'} b_w dt$	=	225	KN	
$V_s = (V_u / \emptyset) - V_c$	=	25.47	<	224.75

Section is Adequate

$A_v = 2 (\pi S_b^2 / 4) = 157.1$	
$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$	
or 600mm otherwise	
$V_s > 0.33 \sqrt{f_c'} b_w d,$	
or 300mm	



Therefore use 200x450 with 9-20mmØ @ support and 9-20mmØ @ midspan Main Bars (Grade 40);

10mmØ 2 leg-stirrups: Sp. at 1@50, 5@90 and rest 200 O.C

Main Bar Spacing Calculator

Sup Main Bar, S = 30 > 25mm

Mid Main Bar, S = 30 > 25mm

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

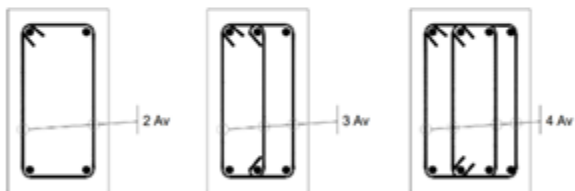
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	61.87	25.47	581.6	50.00	1.00	50.00	Pass!
2h	0.05 - 0.9m	61.72	25.27	586.3	91.50	5.00	90.00	Pass!
> 2h	> 0.9m	58.57	21.07	703.0	183.00	Rest	200.00	Pass!

REINFORCED CONCRETE BEAM

CB - 1 / Beam No. 12130

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, $D_t =$	3	3	$b_w = 250$ mm $f_{yt} = 230$
$f_y = 415$	Bar 2-L, $N_b =$	2	0	$h = 500$ mm $A_v = 2$
$b_1 = .85$	ion Bar, $D_c =$	3	3	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, $D =$	28		$C_c = 40$ mm, Clear Covering
	Moment, $M_u =$	379.2	159.7	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t ;

	Support	Midspan
$As1 = \pi D^2 Db / 4 =$	1847.26	1847.26
$2L, As2 = \pi D^2 Nb / 4 =$	1231.50	0.00
$y = (As1 y1 + As2 y2) / As =$	24.00	0.00
$d' = C_c + S_b + (D/2) + y =$	88.00	64.00
$d_t = h - d' =$	412.00	436.00

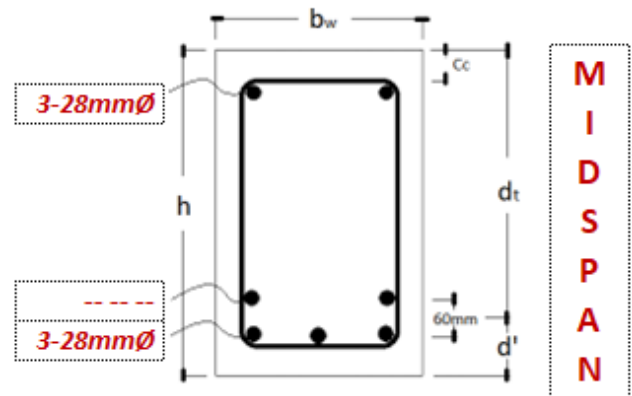
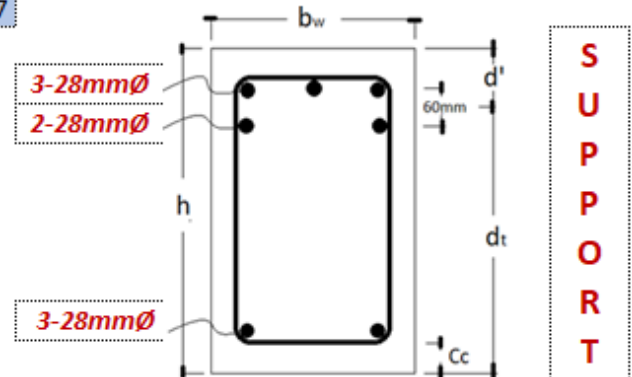
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 d_t / f_{smin} + 600 =$	176.6	186.86
$a_{max} = \beta_1 C_{max} =$	150.1	158.83
$As_{max} = 0.85 f_c' a_{max} b_w / f_y =$	1613.87	1707.89
$a = (As f_y - As' f_y) / 0.85 f_c' b =$	114.53	0.00
$C = a / \beta_1 =$	134.74	0.00
$f_s' = 600 (C - d') / C =$	208.13	#####
$f_s' =$ Compression Bars	Not Yield	Yield
$f_s = 600 (d_t - C) / C =$	1234.69	#####
$f_s =$ Tension Bars	Yield	Not Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$As f_y = 1.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C =$ by quadratic	184.13	98.88
$a = \beta_1 C$	156.51	84.05
$f_s' = 600 (C - d') / C =$	313.25	211.66
$f_s = 600 (d_t - C) / C =$	742.50	2045.58
$M_n = \phi [d_t - (a/2)] + C_s (d_t - d') =$	448.36	293.22
SUPPORT, $\phi M_n =$	403.53	> 379.16 Pass!
MIDSPAN, $\phi M_n =$	263.89	> 159.67 Pass!



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 80 < 163.84$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 316 \text{ KN}$$

$$V_s = (V_u / \phi) - V_c = ##### < 316.24$$

Section is Adequate

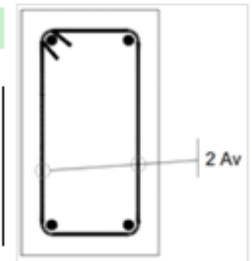
$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$$

$$\text{or } 600 \text{ mm otherwise}$$

$$V_s > 0.33 \sqrt{f_c'} b_w d,$$

$$\text{or } 300 \text{ mm}$$



Therefore use 250x500 with 8-28mmØ @ support and 6-28mmØ @ midspan Main Bars (Grade 60);

10mmØ 2 leg-stirrups: Sp. at 1@50, 5@100 and rest 150 O.C

Main Bar Spacing Calculator

Sup Main Bar, S = 43 > 25mm

Mid Main Bar, S = 43 > 25mm

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

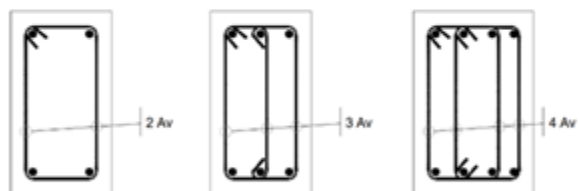
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s > A_{smax}$, Decreased A_{st} !

$A_{smin} < A_s > A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$\rho_{min} \geq 0.25 \rho_{max}$ Ok!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	163.84	138.21	120.2	50.00	1.00	50.00	Pass!
2h	0.05 - 1m	162.52	136.45	121.8	103.00	5.00	100.00	Pass!
> 2h	> 1m	137.47	103.05	161.3	120.24	Rest	150.00	Pass!

REINFORCED CONCRETE BEAM

CB - 2 / Beam No. 12146

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, Dt =	3	3	$b_w = 250$ mm $f_{yt} = 230$
$f_y = 275$	Bar 2-L, Nb =	2	0	$h = 350$ mm $A_v = 2$
$b_1 = .85$	ion Bar, Dc =	3	3	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, D =	16		$C_c = 40$ mm, Clear Covering
	Moment, Mu =	53.7	4.8	

CONDITION : $Val = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$Val, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & dt ;

	Support	Midspan
$As1 = \pi D^2 Db / 4$	= 603.19	603.19
$2L, As2 = \pi D^2 Nb / 4$	= 402.12	0.00
$y = (As1 y1 + As2 y2) / As$	= 24.00	0.00
$d' = Cc + Sb + (D/2) + y$	= 82.00	58.00
$dt = h - d'$	= 268.00	292.00

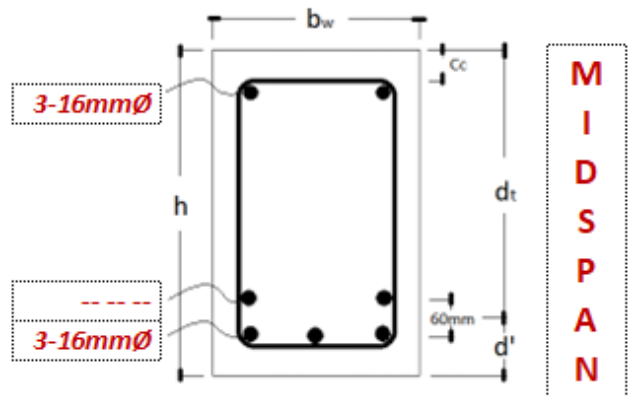
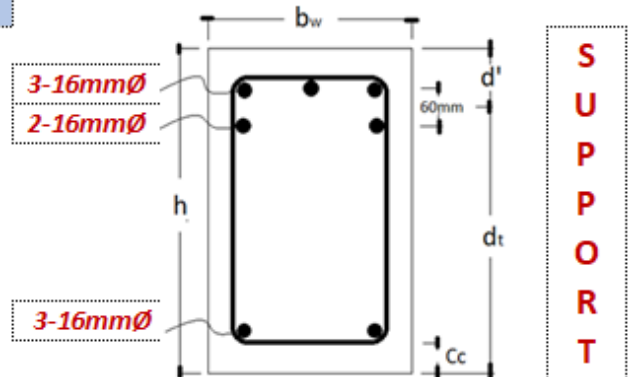
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 dt / f_{smin} + 600$	= 114.9	125.14
$a_{max} = \beta_1 C_{max}$	= 97.6	106.37
$As_{max} = 0.85 f_c' a_{max} b_w / f_y$	= 1584.25	1726.12
$a = (As f_y - As' f_y) / 0.85 f_c' b$	= 61.95	37.17
$C = a / \beta_1$	= 72.88	43.73
$f_s' = 600 (C - d') / C$	= -75.04	-525.07
$f_s' = \text{Compression Bars}$	= Not Yield	Not Yield
$f_s = 600 (dt - C) / C$	= 1606.23	3406.34
$f_s = \text{Tension Bars}$	= Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$As f_y = 1.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic}$	= 77.92	52.98
$a = \beta_1 C$	= 66.23	45.03
$f_s' = 600 (C - d') / C$	= -31.45	-56.90
$f_s = 600 (dt - C) / C$	= 1463.76	2707.16
$M_n = c[dt - (a/2)] + C_s (dt - d')$	= 64.98	46.12
SUPPORT, ϕM_n	= 58.48	> 53.66
MIDSPAN, ϕM_n	= 41.51	> 4.79



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w dt = 52 < 73.84$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w dt = 206 \text{ KN}$$

$$V_s = (V_u / \phi) - V_c = 46.26 < 205.71$$

Section is Adequate

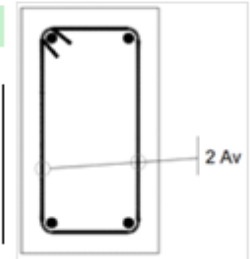
$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$$

$$\text{or } 600 \text{ mm otherwise}$$

$$V_s > 0.33 \sqrt{f_c'} b_w d,$$

$$\text{or } 300 \text{ mm}$$



Therefore use 250x350 with 8-16mm \emptyset @ support and 6-16mm \emptyset @ midspan Main Bars (Grade 40);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 5@60 and rest 200 O.C

Main Bar Spacing Calculator

Sup Main Bar, $S = 61 > 25\text{mm}$

Mid Main Bar, $S = 61 > 25\text{mm}$

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

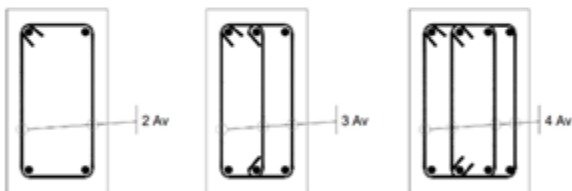
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	73.84	46.26	242.1	50.00	1.00	50.00	Pass!
2h	0.05 - 0.7m	73.72	46.09	243.0	67.00	5.00	60.00	Pass!
> 2h	> 0.7m	72.11	43.95	254.8	134.00	Rest	200.00	Pass!

REINFORCED CONCRETE BEAM

RCB - 1 / Beam No. 22138

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, Dt =	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 415$	Bar 2-L, Nb =	2	0	$h = 450$ mm $A_v = 2$
$b_1 = .85$	ion Bar, Dc =	3	3	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, D =	20		$C_c = 40$ mm, Clear Covering
	Moment, Mu =	154.2	86.4	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & dt ;

	Support	Midspan
$As1 = \pi D^2 Db / 4$	= 942.48	942.48
$2L, As2 = \pi D^2 Nb / 4$	= 628.32	0.00
$y = (As1 y1 + As2 y2) / As$	= 24.00	0.00
$d' = C_c + S_b + (D/2) + y$	= 84.00	60.00
$dt = h - d'$	= 366.00	390.00

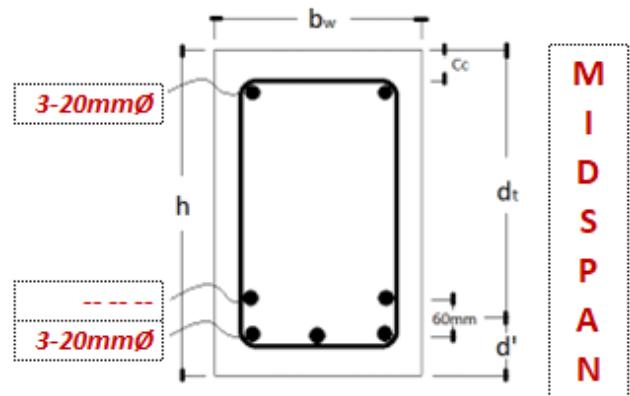
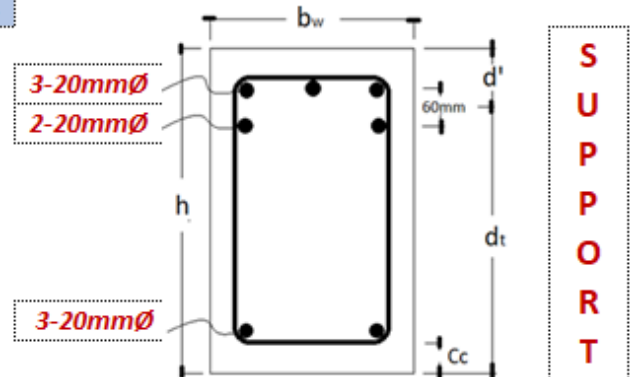
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 dt / f_{smin} + 600$	= 156.9	167.14
$a_{max} = \beta_1 C_{max}$	= 133.3	142.07
$As_{max} = 0.85 f_c' a_{max} b_w / f_y$	= 1146.95	1222.16
$a = (As f_y - As' f_y) / 0.85 f_c' b$	= 73.04	109.56
$C = a / \beta_1$	= 85.93	128.89
$f_s' = 600 (C - d') / C$	= 13.47	208.98
$f_s' = \text{Compression Bars}$	= Not Yield	= Not Yield
$f_s = 600 (dt - C) / C$	= 1955.59	1215.45
$f_s = \text{Tension Bars}$	= Yield	= Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$As f_y = 1.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic}$	= 140.08	80.75
$a = \beta_1 C$	= 119.07	68.64
$f_s' = 600 (C - d') / C$	= 240.21	154.21
$f_s = 600 (dt - C) / C$	= 967.68	2297.65
$M_n = \phi [d t - (a/2)] + C_s (d t - d')$	= 204.98	135.12
SUPPORT, ϕM_n	= 184.48	> 154.24 Pass!
MIDSPAN, ϕM_n	= 121.61	> 86.39 Pass!



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w dt = 57 < 103.67$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w dt = 225 \text{ KN}$$

$$V_s = (V_u / \phi) - V_c = 81.21 < 224.75$$

Section is Adequate

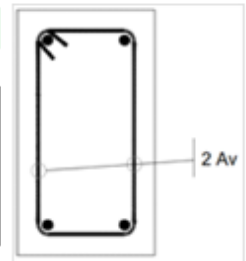
$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$$

$$\text{or } 600 \text{ mm otherwise}$$

$$V_s > 0.33 \sqrt{f_c'} b_w d,$$

$$\text{or } 300 \text{ mm}$$



Therefore use 200x450 with 8-20mmØ @ support and 6-20mmØ @ midspan Main Bars (Grade 60);

10mmØ 2 leg-stirrups: Sp. at 1@50, 5@90 and rest 180 O.C

Main Bar Spacing Calculator

Sup Main Bar, $S = 30 > 25\text{mm}$

Mid Main Bar, $S = 30 > 25\text{mm}$

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

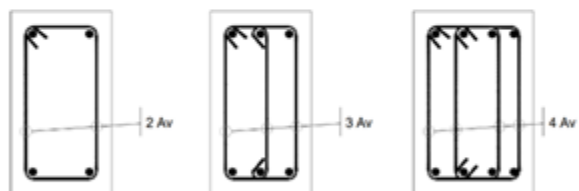
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$\mu_{min} \geq 0.25 \mu_{max}$ Ok!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	103.67	81.21	182.4	50.00	1.00	50.00	Pass!
2h	0.05 - 0.9m	103.52	81.01	182.9	91.50	5.00	90.00	Pass!
> 2h	> 0.9m	100.97	77.59	190.9	182.40	Rest	180.00	Pass!

REINFORCED CONCRETE BEAM

TB - 1 / Beam No. 12131

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, $D_t =$	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 415$	Bar 2-L, $N_b =$	3	0	$h = 400$ mm $A_v = 2$
$b_1 = .85$	ion Bar, $D_c =$	3	3	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, $D =$	20		$C_c = 40$ mm, Clear Covering
	Moment, $M_u =$	159.3	91.0	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t ;

	Support	Midspan
$A_{s1} = \pi D^2 D_b / 4 =$	942.48	942.48
$2L, A_{s2} = \pi D^2 N_b / 4 =$	942.48	0.00
$y = (A_{s1} y_1 + A_{s2} y_2) / A_s =$	30.00	0.00
$d' = C_c + S_b + (D/2) + y =$	90.00	60.00
$d_t = h - d' =$	310.00	340.00

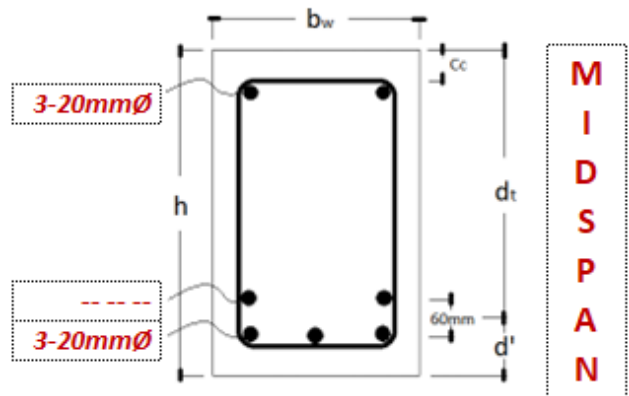
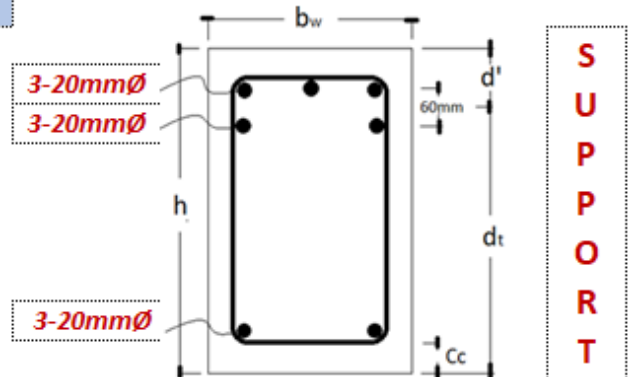
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 d_t / f_{smin} + 600 =$	132.9	145.71
$a_{max} = \beta_1 C_{max} =$	112.9	123.86
$A_{smax} = 0.85 f_c' a_{max} b_w / f_y =$	971.46	1065.47
$a = (A_s f_y - A_s' f_y) / 0.85 f_c' b =$	109.56	109.56
$C = a / \beta_1 =$	128.89	128.89
$f_s' = 600 (C - d') / C =$	181.05	181.05
$f_s' = \text{Compression Bars} =$	Not Yield	Not Yield
$f_s = 600 (d_t - C) / C =$	843.05	982.70
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$A_s f_y = 1.85 f_c' \beta_1 C b_w + A_s' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic} =$	170.11	80.90
$a = \beta_1 C =$	144.59	68.77
$f_s' = 600 (C - d') / C =$	282.55	155.01
$f_s = 600 (d_t - C) / C =$	493.44	1921.63
$M_n = c [d_t - (a/2)] + C_s (d_t - d') =$	197.26	115.93
SUPPORT, $\phi M_n =$	177.54	> 159.30
MIDSPAN, $\phi M_n =$	104.34	> 90.97



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 48 < 111.94$$

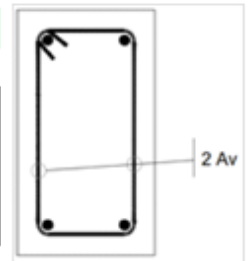
$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 190 \text{ KN}$$

$$V_s = (V_u / \phi) - V_c = \text{#####} < 190.36$$

Section is Adequate

$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

Max S, w/c ever is lesser, mm
 $V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$
or 600mm otherwise
 $V_s > 0.33 \sqrt{f_c'} b_w d,$
or 300mm



Therefore use 200x400 with 9-20mm \emptyset @ support and 6-20mm \emptyset @ midspan Main Bars (Grade 60);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 5@70 and rest 120 O.C

Main Bar Spacing Calculator

Sup Main Bar, S = 30 > 25mm

Mid Main Bar, S = 30 > 25mm

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s > A_{smax}$, Decreased A_{st} !

$A_{smin} < A_s > A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$\mu_{min} \geq 0.25 \mu_{max}$ Ok!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	111.94	100.96	128.8	50.00	1.00	50.00	Pass!
2h	0.05 - 0.8m	111.56	100.45	129.5	77.50	5.00	70.00	Pass!
> 2h	> 0.8m	108.12	95.85	135.7	128.83	Rest	120.00	Pass!

REINFORCED CONCRETE BEAM

FTB - 1 / Beam No. 22

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, $D_t =$	2	2	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 275$	Bar 2-L, $N_b =$	2	2	$h = 400$ mm $A_v = 2$
$b_1 = .85$	ion Bar, $D_c =$	3	3	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, $D =$	16		$C_c = 40$ mm, Clear Covering
	Moment, $M_u =$	45.3	1.6	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t ;

	Support	Midspan
$As1 = \pi D^2 Db / 4 =$	402.12	402.12
$2L, As2 = \pi D^2 Nb / 4 =$	402.12	402.12
$y = (As1 y1 + As2 y2) / As =$	30.00	30.00
$d' = C_c + S_b + (D/2) + y =$	88.00	88.00
$d_t = h - d' =$	312.00	312.00

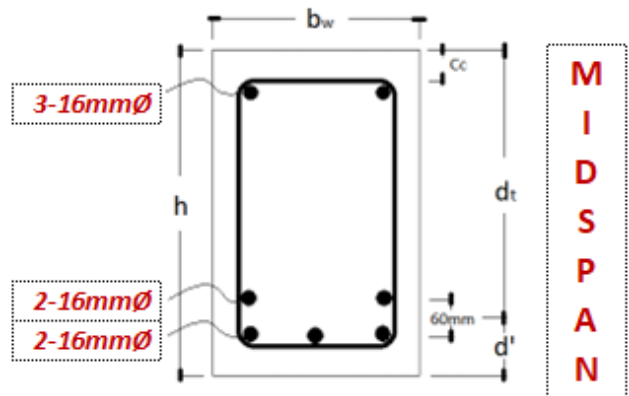
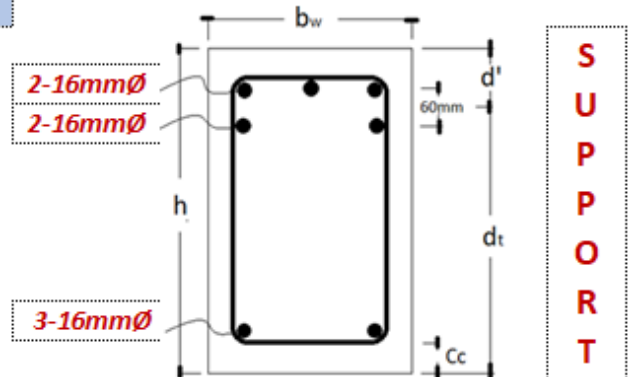
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 d_t / f_{smin} + 600 =$	133.7	133.71
$a_{max} = \beta_1 C_{max} =$	113.7	113.66
$As_{max} = 0.85 f_c' a_{max} b_w / f_y =$	1475.48	1475.48
$a = (As f_y - As' f_y) / 0.85 f_c' b =$	61.95	61.95
$C = a / \beta_1 =$	72.88	72.88
$f_s' = 600 (C - d') / C =$	-124.43	-124.43
$f_s' = \text{Compression Bars} =$	Not Yield	Not Yield
$f_s = 600 (d_t - C) / C =$	1968.45	1968.45
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$As f_y = 1.85 f_c' \beta_1 C b_w + As' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic} =$	81.81	81.81
$a = \beta_1 C =$	69.54	69.54
$f_s' = 600 (C - d') / C =$	-45.41	-45.41
$f_s = 600 (d_t - C) / C =$	1688.28	1688.28
$M_n = c [d t - (a/2)] + C_s (d t - d') =$	62.69	62.69
SUPPORT, $\phi M_n =$	56.42	> 45.32 Pass!
MIDSPAN, $\phi M_n =$	56.42	> 1.62 Pass!



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 49 < 15.47$$

$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 192 \text{ KN}$$

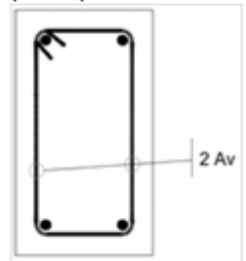
$$V_s = (V_u / \phi) - V_c = (27.99) < 191.59$$

Section is Adequate

$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

Max S, w/c ever is lesser, mm

$V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2$
or 600mm otherwise
 $V_s > 0.33 \sqrt{f_c'} b_w d,$
or 300mm



Therefore use 200x400 with 7-16mm \emptyset @ support and 7-16mm \emptyset @ midspan Main Bars (Grade 40);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 3@70 and rest 200 O.C

Main Bar Spacing Calculator

Sup Main Bar, S = 88 > 25mm

Mid Main Bar, S = 88 > 25mm

Dimensional Limits, 418.6.2.1

$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

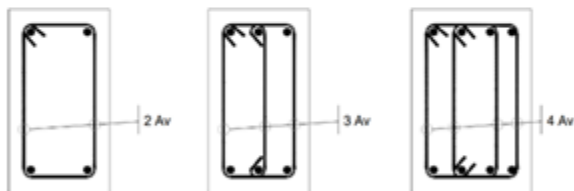
Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!

$A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	15.47	(27.99)	464.7	50.00	1.00	50.00	Pass!
2h	0.05 - 0.8m	15.47	(27.99)	464.7	78.00	3.00	70.00	Pass!
> 2h	> 0.8m	15.47	(27.99)	464.7	156.00	Rest	200.00	Pass!

REINFORCED CONCRETE BEAM

FTB - 2 / Beam No. 4

Input Parameters :

Standard Specs	Momen	Sup Top	Mid Bot	Shear Capacity
$f_c' = 21$	ion Bar, $D_t =$	3	3	$b_w = 200$ mm $f_{yt} = 230$
$f_y = 275$	Bar 2-L, $N_b =$	3	3	$h = 400$ mm $A_v = 2$
$b_1 = .85$	ion Bar, $D_c =$	3	3	$S_b = 10$ mm Stirrups Bar \emptyset
$E_s = 200$ Gpa	Main Bar dia, $D =$	16		$C_c = 40$ mm, Clear Covering
	Moment, $M_u =$	69.3	4.5	

CONDITION : $V_{al} = 0.65 + 0.25 (\epsilon_t - \epsilon_{ty} / 0.005 - \epsilon_{ty})$

$$\phi = 0.65, \epsilon_t \leq \epsilon_{ty}$$

$$V_{al}, \epsilon_{ty} < \epsilon_t < 0.005$$

$$0.90, \epsilon_t \geq 0.005$$

Location of d' & d_t ;

	Support	Midspan
$A_{s1} = \pi D^2 D_b / 4 =$	603.19	603.19
$2L, A_{s2} = \pi D^2 N_b / 4 =$	603.19	603.19
$y = (A_{s1} y_1 + A_{s2} y_2) / A_s =$	30.00	30.00
$d' = C_c + S_b + (D/2) + y =$	88.00	88.00
$d_t = h - d' =$	312.00	312.00

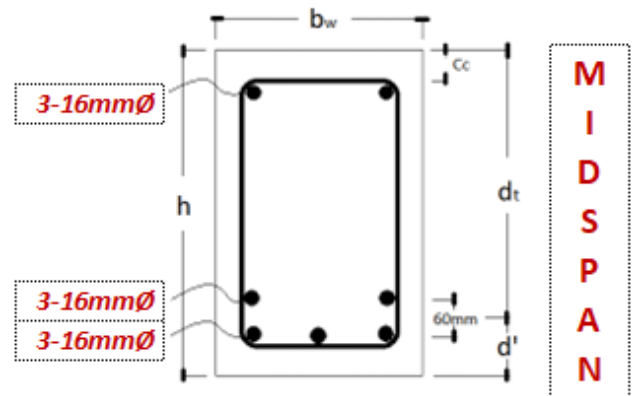
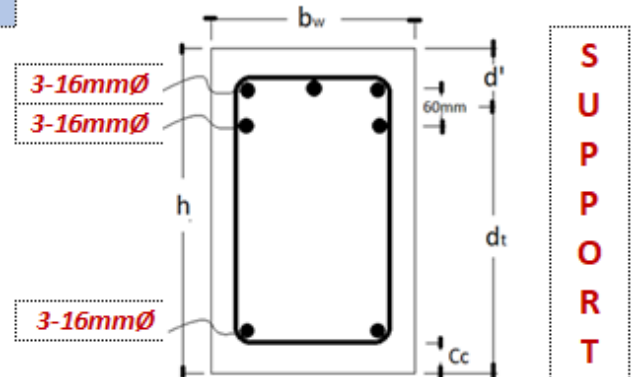
CHECKING : $\epsilon_t \geq 0.004$,

	Support	Midspan
$C_{max} = 600 d_t / f_{smin} + 600 =$	133.7	133.71
$a_{max} = \beta_1 C_{max} =$	113.7	113.66
$A_{smax} = 0.85 f_c' a_{max} b_w / f_y =$	1475.48	1475.48
$a = (A_s f_y - A_s' f_y) / 0.85 f_c' b =$	92.93	92.93
$C = a / \beta_1 =$	109.33	109.33
$f_s' = 600 (C - d') / C =$	117.04	117.04
$f_s' = \text{Compression Bars} =$	Not Yield	Not Yield
$f_s = 600 (d_t - C) / C =$	1112.30	1112.30
$f_s = \text{Tension Bars} =$	Yield	Yield

BEAM MOMENT CAPACITY $\phi = 0.9$

$$A_s f_y = 1.85 f_c' \beta_1 C b_w + A_s' f_s' \text{ Where, } f_s' = (600 C - d') / C$$

	Support	Midspan
$C = \text{by quadratic} =$	97.56	97.56
$a = \beta_1 C =$	82.93	82.93
$f_s' = 600 (C - d') / C =$	58.82	58.82
$f_s = 600 (d_t - C) / C =$	1318.74	1318.74
$M_n = c [d_t - (a/2)] + C_s (d_t - d') =$	88.04	88.04
SUPPORT, $\phi M_n =$	79.24	> 69.25 Pass!
MIDSPAN, $\phi M_n =$	79.24	> 4.48 Pass!



CHECK SHEAR; $\phi = 0.75$

$$V_c = 0.17 \sqrt{f_c'} b_w d_t = 49 < 78.51$$

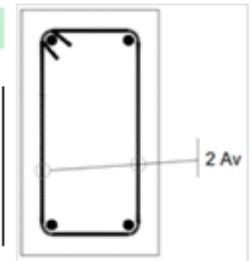
$$V_{smax} = 0.67 \sqrt{f_c'} b_w d_t = 192 \text{ KN}$$

$$V_s = (V_u / \phi) - V_c = 56.07 < 191.59$$

Section is Adequate

$$A_v = 2 (\pi S_b^2 / 4) = 157.1$$

$$\begin{aligned} & V_s \leq 0.33 \sqrt{f_c'} b_w d, d/2 \\ & \text{or } 600 \text{ mm otherwise} \\ & V_s > 0.33 \sqrt{f_c'} b_w d, \\ & \text{or } 300 \text{ mm} \end{aligned}$$



Therefore use 200x400 with 9-16mm \emptyset @ support and 9-16mm \emptyset @ midspan Main Bars (Grade 40);

10mm \emptyset 2 leg-stirrups: Sp. at 1@50, 3@70 and rest 200 O.C

Main Bar Spacing Calculator

Sup Main Bar, $S = 36 > 25\text{mm}$
Mid Main Bar, $S = 36 > 25\text{mm}$

Dimensional Limits, 418.6.2.1

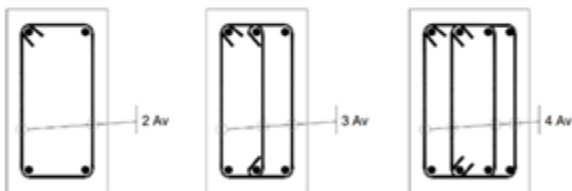
$b_w \geq \max[.3h, 200\text{mm}]$ Ok!

Main Reinforcements Ratio Limits, 418.6.3.1

$A_{smin} < A_s < A_{smax}$, Ok!
 $A_{smin} < A_s < A_{smax}$, Ok!

Main Reinforcements, 418.6.3.2

$M_{umin} \geq 0.25 M_{umax}$ Increased Mumin!



Add extra Stirrups to increase area of Shear resisting steel, A_v

NSCP 2015 418.6.4

Beam mark on critical	Beam Length, m	V_u	V_s	S_{max}	Req per Seismic	Stirrups Spacing		
						Qty	mm	
	0 - 0.05m	78.51	56.07	232.0	50.00	1.00	50.00	Pass!
2h	0.05 - 0.8m	78.51	56.07	232.0	78.00	3.00	70.00	Pass!
> 2h	> 0.8m	78.51	56.07	232.0	156.00	Rest	200.00	Pass!

FOOTINGS

PROPOSED TWO STOREY COMMERCIAL BUILDING

ISOLATED RECTANGULAR FOOTING DESIGN

F - 1 / Node No. 29

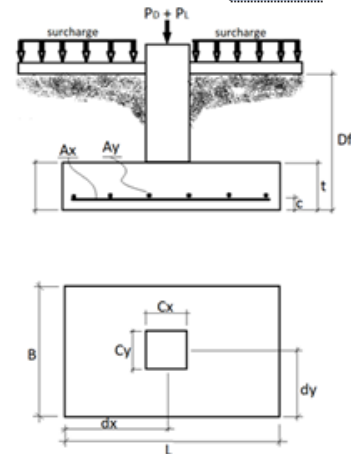
Input Parameters:

Concrete Strength,	$f_c' = 24$	Mpa
Rebar yield strength,	$f_y = 230$	Mpa
Net allowable Soil Pressure,	$q_a = 100$	kPa
Footing Embedment Depth,	$D_f = 1.85$	m
Surcharge,	$q_s = 0$	kPa
Soil Weight,	$w_s = 16$	kN/m ³
Footing Thickness,	$t = 0.45$	m
Length,	$L = 2.2$	m
Width,	$B = 2.2$	m
Clear Covering,	$c = 70$	mm

Longitudinal Bar,	$A_x = 10$	mm ϕ
Traverse Bar,	$A_y = 10$	mm ϕ
Loc X - dir	$dx = 0$	m, 0 from center
Loc Y - dir	$dy = 0$	m, 0 from center
Depth,	$C_x = 0.35$	m
Width,	$C_y = 0.35$	m
Load,	$P_d = 347.408$	KN
Load,	$P_l = 101.026$	KN
Moment X,	$M_x = -2.399$	KNm
Moment Y,	$M_y = -1.141$	KNm

Check Soil Bearing Capacity

Applied Load,	$P_d + P_l = 448.43$	
Surcharge,	$q_s (LB) = 0.00$	
Weight Footing,	$(23.5 - w_s) tBL = 16.34$	
	$P_n = 464.77$	kN
$M_x = 2.399$	KNm	$M_y = 1.141$ KNm
$e_x = 0.005$	m	$L/6 = 0.367$ m
$e_y = 0.003$	m	$B/6 = 0.3667$ m
$q_{nx(max)} = \frac{P}{BL} + \frac{6M}{L^2 B}$	$= 97.38$	< 100.00 Pass!
$q_{ny(max)} = \frac{P}{BL} + \frac{6M}{B^2 L}$	$= 96.67$	< 100.00 Pass!



Check Thickness ; Two-way Shear

Applied Load,	$1.2P_d + 1.6P_l = 578.53$	
Surcharge,	$1.2 q_s (LB) = 0.00$	
Weight Footing,	$1.2(23.5 - w_s) tLB = 19.60$	
	$P_u = 598.13$	
$M_x = 2.399$	KNm	$M_y = 1.141$ KNm
$e_x = 0$		$e_y = 0.00$
$L/6 = 0.37$		$L/6 = 0.367$
$q_{umaxx} = 124.933$	Kpa	$q_{umaxy} = 124.2242$ Kpa
$d = 0.364$	m	
$V_{ux} = q_u (BL - (C_x + d)(C_y + d))$	$= 535.13$	KN
$V_{uy} = q_u (BL - (C_x + d)(C_y + d))$	$= 535.13$	KN
$b_o = 2(D_1 + d) 2(W_1 + d)$	$= 2.856$	m
$\phi V_{c1} = \phi 0.33 \sqrt{f_c'} b_o d$	$= 1260.493$	KN
$\beta_c = \text{Long/short side of column} = 1$		
$\phi V_{c2} = \phi (1 + \frac{2}{\beta_c}) .17 \sqrt{f_c'} b_o d$	$= 1948$	KN
$\alpha_s = 40$		
$\phi V_{c2} = \phi (2 + \frac{\alpha_s d}{\beta_c}) .083 \sqrt{f_c'} b_o d$	$= 5250.07$	

Check One-way Shear;

must, $V_c > V_u$

$V_{ux} = q_u B[(B - C)/2 - d]$	$= 151.28$	KN
$V_{uy} = q_u L[(L - C)/2 - d]$	$= 151.93$	KN
$\phi V_{cx} = \phi 0.17 \sqrt{f_c'} B d$	$= 500.20$	KN Pass!
$\phi V_{cy} = \phi 0.17 \sqrt{f_c'} L d$	$= 500.20$	KN Pass!

Check Flexural Reinforcement; $A_{smin} = 0.002Bt$

$M_{ux} = 115.40$	KNm	$M_{uy} = 115.88$	KNm
$A_{sx} = 2010.62$	mm ²	$A_{sy} = 2010.6$	mm ²
$A_{smx} = 1980.00$		$A_{smy} = 1980.0$	mm ²
$S_x = 211.1$	mm	$S_y = 211.1$	mm ($S_{max} = 450mm$)
$a_x = \frac{A_{sx} f_y}{.85 f_c' B}$	$= 10.304$	mm,	$a_y = 10.3$ mm

Check Tension Contolled Limit $\phi = 0.9$

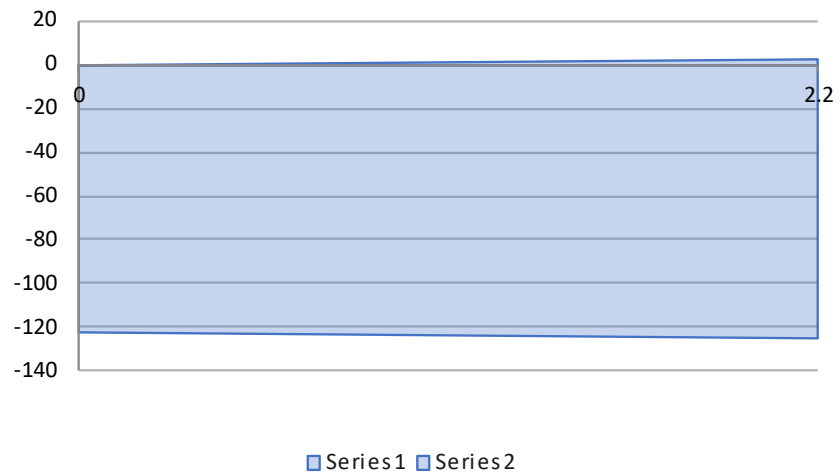
$a_b/d = 0.614 > a_x/d \text{ \& } a_y/d$	
$a_x/d = 0.028$	$a_y/d = 0.028$

$\phi M_{nx} = \phi A_{sx} f_y (d - \frac{a_x}{2})$	$\phi M_{ny} = \phi A_{sy} f_y (d - \frac{a_y}{2})$
---	---

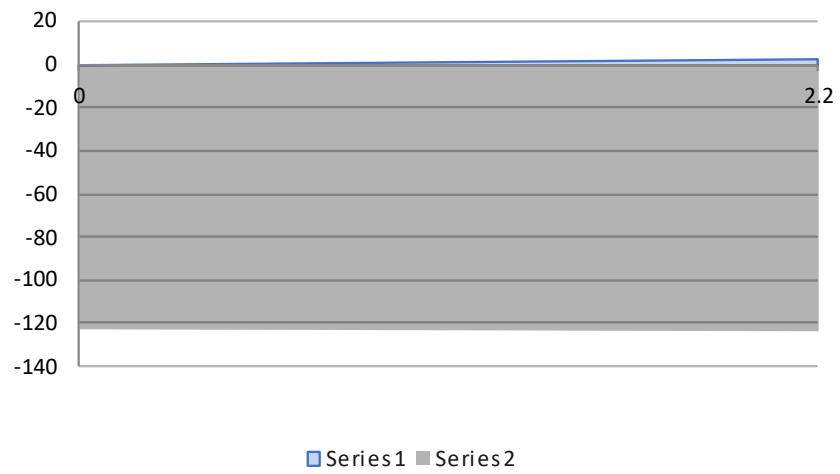
$\phi V_c = \min \phi V_{c1}, \phi V_{c2}, \phi V_{c3}$	$1260 > 535$	Pass!
$\phi M_{nx} = 149.35$	KNm,	$\phi M_{ny} = 149.35$ KNm
$> \mu_u$	Pass!	$> \mu_u$ Pass!

Therefore use, 2.2x2.2x0.45m thick Footing with 16mm ϕ Tension Bar Grade (33) sp. @ 211.11mm and 211mm along BL respectively O.C.

SOIL PRESSURE ALONG L @ FACTORED LOAD



SOIL PRESSURE ALONG B @ FACTORED LOAD



ISOLATED RECTANGULAR FOOTING DESIGN

F - 2 / Node No. 21

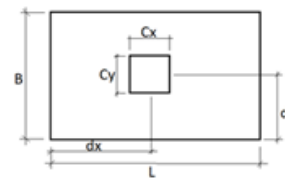
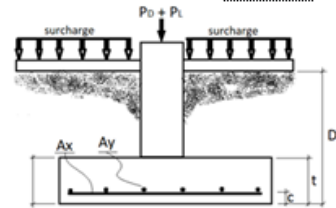
Input Parameters:

Concrete Strength,	$f_c' =$	21	Mpa
Rebar yield strength,	$f_y =$	230	Mpa
Net allowable Soil Pressure,	$q_a =$	100	kPa
Footing Embedment Depth,	$D_f =$	1.85	m
Surcharge,	$q_s =$	0	kPa
Soil Weight,	$w_s =$	16	kN/m ³
Footing Thickness,	$t =$	0.45	m
Length,	$L =$	1.6	m
Width,	$B =$	1.6	m
Clear Covering,	$c =$	70	mm

Longitudinal Bar,	Ax =	9	16	mmØ
Traverse Bar,	Ay =	9	16	mmØ
Loc X - dir	dx =	0	m, 0 from center	
Loc Y - dir	dy =	0	m, 0 from center	
Depth,	Cx =	0.35	m	
Width,	Cy =	0.35	m	
Load,	Pd =	192.271	KN	
Load,	Pl =	36.926	KN	
Moment X,	Mx =	1.124	KNm	
Moment Y,	My =	2.249	KNm	

Check Soil Bearing Capacity

Applied Load,	$P_d + P_l =$	229.20
Surcharge,	q_s (LB) =	0.00
Weight Footing,	$(23.5 - w_s) tBL =$	8.64
	$P_n =$	237.84 kN
$M_x = -1.124$	KNm	$M_y = -2.249$ KNm
$e_x = -0.005$	m	$L/6 = 0.267$ m
$e_y = -0.010$	m	$B/6 = 0.2667$ m
$q_{nx}(\max) = \frac{P}{BL} + \frac{6M}{L^2B}$	=	94.55 < 100.00 Pass!
$q_{ny}(\max) = \frac{P}{BL} + \frac{6M}{B^2L}$	=	96.20 < 100.00 Pass!



Check Thickness ; Two-way Shear

Applied Load,	$1.2P_d + 1.6P_l =$	289.81
Surcharge,	$1.2 q_s$ (LB) =	0.00
Weight Footing,	$1.2(23.5 - w_s) tBL =$	10.37
	$P_u =$	300.17
$M_x = -1.124$	$M_y = -2.249$	
$e_x = -0$	$e_y = -0.01$	
$L/6 = 0.27$	$L/6 = 0.267$	
$q_{umaxx} = 118.902$	$q_{umaxy} = 120.5502$	Kpa
$d = 0.364$	m	
$V_{ux} = q_u (BL - (C_x + d)(C_y + d))$	=	240.40 KN
$V_{uy} = q_u (BL - (C_x + d)(C_y + d))$	=	240.40 KN
$b_o = 2(D_1 + d) 2(W_1 + d)$	=	2.856 m
$\phi V_{c1} = \phi 0.33 \sqrt{f_c'} b_o d$	=	1179.083 KN
$\beta_c = \text{Long/short side of column} =$	1	
$\phi V_{c2} = \phi (1 + \frac{2}{\beta_c}) .17 \sqrt{f_c'} b_o d$	=	1822 KN
$\alpha_s =$	40	
$\phi V_{c2} = \phi (2 + \frac{\alpha_s d}{\beta_c}) .083 \sqrt{f_c'} b_o d$	=	4910.99

Check One-way Shear;

must, $V_c > V_u$

$V_{ux} = q_u B[(B - C)/2 - d]$	=	48.39	KN
$V_{uy} = q_u L[(L - C)/2 - d]$	=	47.81	KN
$\phi V_{cx} = \phi 0.17 \sqrt{f_c'} B d$	=	340.28	KN Pass!
$\phi V_{cy} = \phi 0.17 \sqrt{f_c'} L d$	=	340.28	KN Pass!

Check Flexural Reinforcement; $A_{smin} = 0.002Bt$

$M_{ux} = 36.26$	KNm	$M_{uy} = 35.88$	KNm
$A_{sx} = 1809.56$	mm ²	$A_{sy} = 1809.6$	mm ²
$A_{smx} = 1440.00$		$A_{smy} = 1440.0$	mm ²
$S_x = 164.5$	$S_y = 165$	mm	($S_{max} = 450\text{mm}$)
$a_x = \frac{A_{sx} f_y}{.85 f_c B}$	=	14.573	mm, $a_y = 14.57$ mm

Check Tension Contolled Limit $\phi = 0.9$

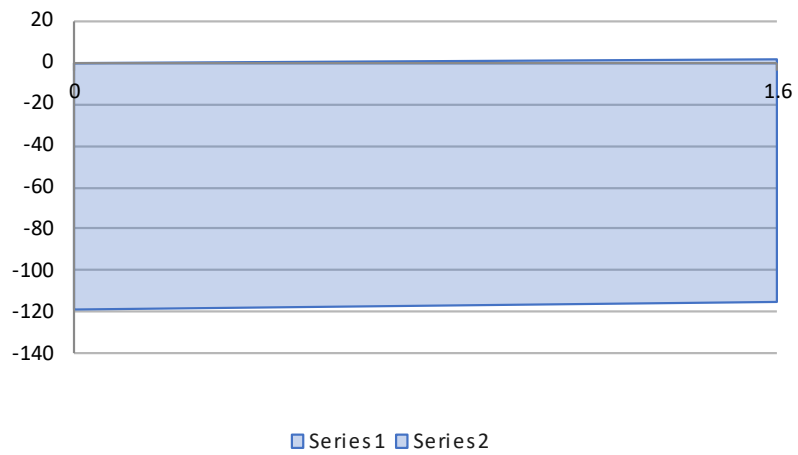
$a_b/d = 0.614 > a_x/d \& a_y/d$	
$a_x/d = 0.04$	$a_y/d = 0.040$

$$\phi M_{nx} = \phi A_{sx} f_y (d - \frac{a_x}{2}) \quad \phi M_{ny} = \phi A_{sy} f_y (d - \frac{a_y}{2})$$

$\phi V_c = \min \phi V_{c1}, \phi V_{c2}, \phi V_{c3}$	1179	>	240	Pass!
$\phi M_{nx} = 133.62$	KNm,	$\phi M_{ny} = 133.62$	KNm	
	>	μ_u	Pass!	
		>	μ_u	Pass!

Therefore use, 1.6x1.6x0.45m thick Footing with 16mm ϕ Tension Bar Grade (33) sp. @ 164.5mm and 164mm along BL respectively O.C.

SOIL PRESSURE ALONG L @ FACTORED LOAD



SOIL PRESSURE ALONG B @ FACTORED LOAD

