RCDC (SACD) V09.03.00

Release Notes

RCDC V09.03.00 is here with new features enhancing the design capabilities. The newly introduced features are:

No	Module	Description
1	General	Reading Repeat (Non-linear) Load Cases from STAAD
2	General	Euro Code - Shear calculation enhancement - All Module
3	Column	IS 13920-2016 Joint check – Additional Option – Column Capacity check for all load combinations
4	Beam	Euro Code – Report Presentation Enhancement
5	General	Enhancements
6	General	Defects - Resolved

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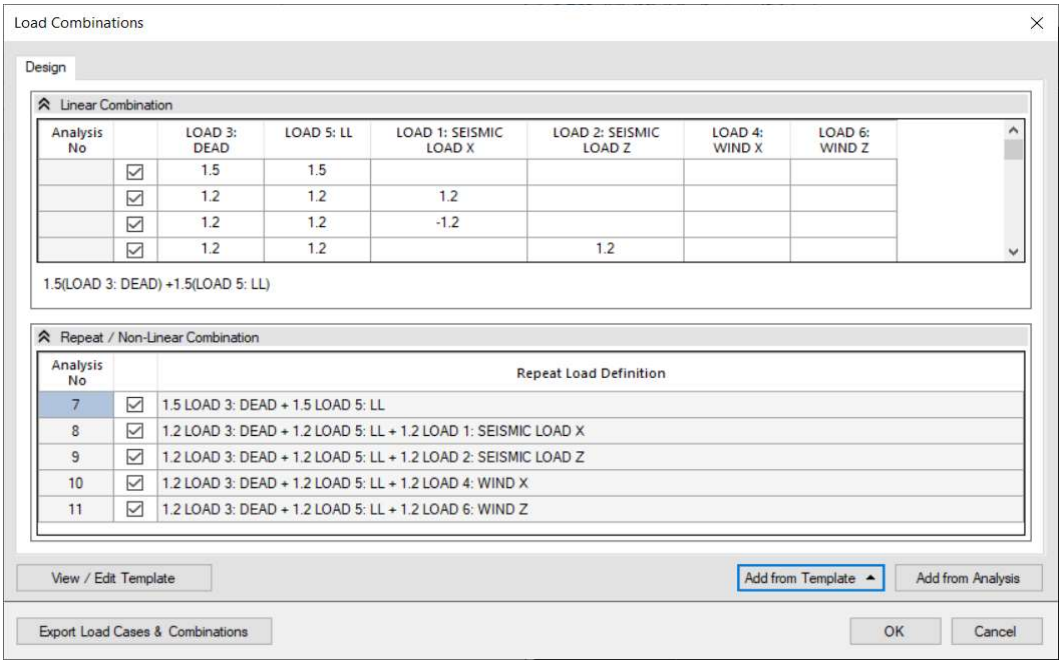
General — Reading Repeat (Non-linear) Load Cases from STAAD

RCDC will now read the member forces from STAAD file for Repeat Load Cases with much easier process. This would enable users to adopt the latest methods of designing structures for results from P-Delta analysis or any other non-linear analysis
Below is the new form for Load combinations in case the analysis file consists of repeat load cases.



General — Euro Code - Shear calculation enhancement - All Module

Calculations for Shear Design and shear reinforcement has been updated with value of permissible stress as per clause 6.2.3 - Note 3 and value of effective depth as per clause 6.2.3 of BS EN 1992-1-1 2004. This is applicable only if the shear reinforcement is required for the section.
This Enhancement is done for all modules of RCDC.
Following are specific examples -
Column Shear Link calculation report:

Along B

Critical Analysis Load Combination	:	16
Critical Load Combination	=	[6] : 1.5 (LOAD 1: LOAD CASE 1) +1.5 (LOAD 3: LOAD CASE 3 EQ
Design shear force, Vux	=	786.2551 kN
NEd	=	609.11 kN
Design shear stress ,vEd	=	1.7441 N/mm^2
VRD,c	=	275.6314 kN
As tension	=	1357.2 sqmm
CRdc	=	0.18/γc
	=	0.15
beff	=	644 mm
k	=	MIN((1 + SQRT(200 / beff)),2)
	=	1.5573
ρ1	=	Asmain / (d x beff)
<>	=	0.003 %
k1	=	0.15
σcp	=	NEd / (B x D)
	=	1.2431 N/mm^2
Shear check		Shear Reinforcment Required
		Since VRD,C < Vux
Calculation for Concrete Strut Capacity vRd,max in terms of stress	=	1287.05 N/mm^2
$v_{Rd,max}$ cot θ = 2.5	=	3.17 N/mm^2
$v_{Rd,max}$ cot θ = 1	=	4.6
Calculation for spacing of shear reinforcement for cot θ = 2.5		
no of legs for stirrups	=	4 legged
Shear reinforcement bar dia ,Ølink	=	8 mm
Area of Shear reinforcement ,Asw	=	1614.82 mm^2
Design yeild stress for shear reinforcement,fywd	=	336 N/mm^2
Spacing of Reinforcement required,s	=	1409.79 mm
Provided Spacing ,sprov.	=	125 mm
Area of Shear reinforcement provided ,Asw,prov	=	143.18 mm^2

Footing Shear Link calculation report:

Design For Shear:

One Way Shear Along L:

Critical Section @ d from Column Face	=	552 mm
Critical Analysis Load Combination	=	11
Critical Load Combination	=	[10] : 1.5 (LOAD 1: LOAD CASE 1) +1.5 (LOAD 2: LOAD CASE 2)
V_{Ed}	=	4212.09 kN
m_{Edx}	=	-22.73 kNm
m_{Edy}	=	7.96 kNm
V_{Ed}/A	=	238.78 kN/sqm
M_{Edx}/Zxx	=	-1.84 kN/sqm
M_{Edy}/Zyy	=	0.64 kN/sqm
Deff	=	552 mm
Beff	=	4200 mm
σ_{max}	=	240.62 kN/sqm
Δv_{Ed}	=	1210.71 kN
v_{Ed}	=	0.52 N/sqmm
$V_{Rd,c}$	=	0.37 N/sqmm
Enhanced Shear Strength $V_{Rd,ce}$	=	0.37 N/sqmm
v_{Ed}	>	$V_{Rd,ce}$ Provide Shear Reinforcement
Asv	=	3577.71 sqmm
	=	6L-T12 @ 130

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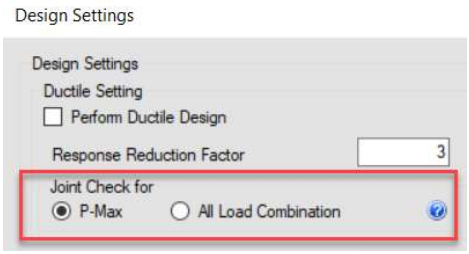
Column	IS 13920-2016 Joint check – Additional Option – Column Capacity check for all load combinations

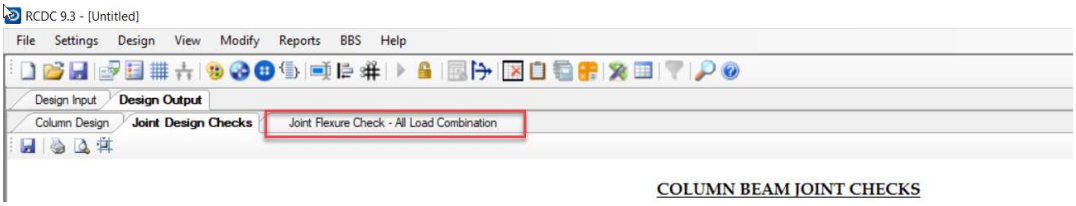
Column Joint check (Seismic detailing as per IS 13920 - 2016) – User can select the 'Joint Check' to be performed by one of the two methods - 1) For Maximum Axial Force (current method) at the Joint from all combinations that include component due to Earthquake load, 2) For Axial Force from each combination that has component due to Earthquake load



P-Max: In this option, Column Moment capacity would be considered for maximum axial force at that joint from load combinations that have Earthquake component.

All Load Combination: In this option, column moment capacity shall be considered corresponding to all axial forces from load combinations that have Earthquake component. The combination that has least factor of safety shall be presented as 'Critical Combination'

If user selects the New method, additional report for Joint check will be generated for Joint check. The New report will also be generated for ACI codes.



COLUMN BEAM JOINT CHECKS

Check for Column Flexural Capacity		
	Along D	**Along B**
Critical Analysis Load Combination Top	22	22
Critical Load Combination Top	[12] : 0.9 (LOAD 1: LOAD CASE 1) +1.5 (LOAD 4: LOAD CASE 4 EQ-Y)	[12] : 0.9 (LOAD 1: LOAD CASE 1) +1.5 (LOAD 4: LOAD CASE 4 EQ-Y)
Pu Top (kN)	163.71	163.71
Mnc Top (kNm)	600.24	600.24
Critical Analysis Load Combination Bot	22	22
Critical Load Combination Bot	[12] : 0.9 (LOAD 1: LOAD CASE 1) +1.5 (LOAD 4: LOAD CASE 4 EQ-Y)	[12] : 0.9 (LOAD 1: LOAD CASE 1) +1.5 (LOAD 4: LOAD CASE 4 EQ-Y)
Pu Bot (kN)	228.72	228.72
Mnc Bottom (kNm)	315.67	315.67
Mnc (kNm)	915.92	915.92
	>= 1.4 x Mnb, Hence OK	>= 1.4 x Mnb, Hence OK

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Check for Column Flexural Capacity										
Load Combination	Top Column	Bottom Column	Joint Flexure Check Along D				Joint Flexure Check Along B			
	Pu (kN)	Pu (kN)	Mnc Top (kNm)	Mnc Bottom (kNm)	Mnc Total (kNm)	Design Check Mnc Total/Mnb	Mnc Top (kNm)	Mnc Bottom (kNm)	Mnc Total (kNm)	Design Check Mnc Total/Mnb
2	324.26	476.72	633.67	378.19	1011.87	2.86	633.67	378.19	1011.87	2.86
3	380.6	593.35	645.22	405.72	1050.94	2.98	645.22	405.72	1050.94	2.98
4	301.7	428.33	629.05	366.54	995.59	2.82	629.05	366.54	995.59	2.82
5	403.16	641.75	649.84	415.98	1065.82	3.02	649.84	415.98	1065.82	3.02
6	343.34	530.61	637.58	391.17	1028.75	2.91	637.58	391.17	1028.75	2.91
7	413.76	676.4	652.02	423.32	1075.34	3.04	652.02	423.32	1075.34	3.04
8	315.13	470.12	631.8	376.6	1008.41	2.85	631.8	376.6	1008.41	2.85
9	441.97	736.89	657.8	436.14	1093.94	3.1	657.8	436.14	1093.94	3.1
10	191.92	289.21	606.55	332.68	939.23	2.66	606.55	332.68	939.23	2.66
11	262.34	435	620.98	368.15	989.13	2.8	620.98	368.15	989.13	2.8
12	163.71	228.72	600.24	315.67	**915.92**	**2.59**	600.24	315.67	**915.92**	**2.59**
13	290.55	495.49	626.76	382.71	1009.48	2.86	626.76	382.71	1009.48	2.86

Beam — Euro Code – Report Presentation Enhancement

Detailed design calculations for Beam. Below are the snaps of updated design calculation report.

Group		:	**G1**	
Beam No		:	**B1**	
Analysis Reference (Member)	16.258m	:	7001	
Beam Length		:	8000	mm
Breadth (b_w)		:	400	mm
Depth (h)		:	800	mm
Effective Depth (d)		:	750	mm
Design Code		:	EN 02 - 2004	
Beam Type		:	Ductile Beam	
Grade Of Concrete (f_{ck}) (Cylindrical)		:	C20/25	N/sqmm
Partial Factor for Concrete (Υ_c)		:	1.5	
Partial Factor for Concrete (Υ_{cd})		:	1.2	
Grade Of Steel (f_{yk})		:	Fy420	N/sqmm
Partial Factor for Reinforcement (Υ_s)		:	1.15	
Partial Factor for Reinforcement (Υ_{sd})		:	1	
Clear Cover (c_{nom})		:	20	mm
Es		:	2x10^5	N/sqmm
K'		:	0.21	
$A_{s,max}$		:	12800	sqmm
$A_{s,min\ (flex)}$ (B)		:	789.44	sqmm
$A_{s,nominal}$ (Bn)		:	640	sqmm
$A_{s,min}$ (user input) (B')		:	416	sqmm

Bentley Advancing Infrastructure

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Flexure Design						
	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Critical L/C - Analysis	16	11	17	17	20	16
Critical L/C - RCDC	6	1	7	7	10	6
Mu (kNm)	101.75	152.2	62.39	240.1	12.02	286.32
Mu/(bd2 x Fck)	0.023	0.034	0.014	0.053	0.003	0.064
z (mm)	712.5	712.5	712.5	712.5	712.5	705.21
Doubly Reinforced Section						
M' (Excess Moment for Doubly Reinforced section) (kNm)	0	0	0	0	0	0
x (Distance of N.A.) (mm)	0	0	0	0	0	0
fsc (Compressive Stress in Steel) (N/sqmm)	0	0	0	0	0	0
Asc (Area of Compression Reinf.) (sqmm) (C)	0	0	0	0	0	0
ρ (%) (Flexural)	0.113	0.195	0.069	0.267	0.013	0.322
A_s (sqmm) (A)	340.01	584.87	208.48	802.32	40.17	966.66
Ted (kNm)	15	0	15	30	9	30
$T_{Rd,c}$ (kNm)	61.13	48.9	61.13	61.13	61.13	61.13
As,min (Tor) (sqmm)	0	0	0	0	0	0
$A_{s,reqd}$ (sqmm)	789.44	789.44	789.44	802.32	789.44	966.66
$A_{s,prov}$ (sqmm)	804.24	804.24	804.24	1005.3	1005.3	1005.3
Reinforcement Provided	4-T16	4-T16	4-T16	5-T16	5-T16	5-T16

Note: Calculation of Ast				
Ast, $_{reqd}$	=	Max{B,B', A+D/2, A+C x (fsc / fyd)+D/2} (for Mu > 0)		
Ast	=	Bn (for Mu = 0)		
Where,				
A	=	A_s	=	Tension reinforcement required for bending moment
B	=	As,min (flex)	=	Min area of flexural reinforcement
Bn	=	As,nominal	=	Nominal area of reinforcement
C	=	Asc	=	Compression reinforcement required for bending moment
D	=	$A_{sl,dist}$	=	Distributed longitudinal torsional reinforcement at section considered
$A_{sl,dist}$			=	Max(As,min (Tor), A_{sl} x ((2B) / (2B + 2D)))

General Enhancements

Following are the Enhancements done in this release.

- **TFS ID – 1074534**

  ACI slab design Moment calculation along Longer span has been enhanced as per Lx/Ly ratio.

Design Moments:				
Short Span Positive Moment At Midspan -				
	M1	=	12.6	kNm
	M1 (per m)	=	M1/Effective Width	
		=	6.3	kNm/m
	Area Of Reinforcement Required (BM)	=	193.12	sqmm/m
	Reinforcement Provided	=	#10 @ 300 C/C	
		=	236	sqmm/m

Short Span		Long Span		
	Side1	Side2	Side1	Side2
Beam				
B (mm)	350	600	600	600
D (mm)	900	900	900	900
Ib (mm^4) x10^6	21262.5	36450	36450	36450
Adjacent Slab				
Thk (mm)	-	275	200	200
Span (mm)	-	8900	8000	5710
Ib (mm^4) x10^6	1903.33	9615.51	5333.33	4570
αf lx, αf ly	11.17	3.79	6.83	7.98
αf	7.44			
Ln (mm)	5235		7400	
L2 (mm)	4300		3092.5	
Effective Width (mm)	2000		1427.5	
	Ly/Lx		Lx/Ly	
	1.4		0.71	
Total BM (kNm)	194.44		279.42	
Bottom				
Moment Co-efficent	0.35		0.35	
Distributed Moment (kNm)	68.05		97.8	
Moment factor for CS	0.63		0.84	
CS Moment (kNm)	42.85		81.75	
MS Moment (kNm)	25.2		16.05	
Moment on Beam (kNm)	36.42		69.48	
Design Moment M1, M3 (kNm)	25.2		16.05	
Top				
Moment Co-efficent	0.65		0.65	
Distributed Moment (kNm)	126.39		181.62	
Moment factor for CS	0.63		0.84	
CS Moment (kNm)	79.58		151.81	
MS Moment (kNm)	46.8		29.81	
Moment on Beam (kNm)	67.65		129.04	
Design Moment M2, M4 (kNm)	46.81		29.81	

- **TFS ID – 1088062**

  Beam capacity calculation for Joint check based on provided reinforcement for IS and ACI has been enhanced. At end section, effect of reinforcement provided at top and bottom of Beam is considered to calculate the Beam capacity. The criteria of reinforcement calculated at opposite to the tension face of the beam must be at least 50% of tension reinforcement has been considered for calculation of Beam capacity in Joint check.

  IS code

Check At Beam-Column Joints:

1. Flexure Strength Of Joint:

Moment Capacity Calculations for Beam

Concrete Gra = M25 N/sqmm

Steel Grade,f = Fe415 N/sqmm

Beam Size	Beam angle w.r.t. column Ly	Torsion moment (Mt)	Moment Capacity for Top Reinforcement				Moment Capacity for Bottom Reinforcement				Resultant Moment			
(mm)	(deg)	(kNm)	Mu (kNm)	Ast Req (sqmm)	Ast Pro (sqmm)	Mu Cap (kNm)	Mu (kNm)	Ast Req (sqmm)	Ast Pro (sqmm)	Mu Cap (kNm)	Top @ D (kNm)	Top @ B (kNm)	Bot @ D (kNm)	Bot @ B (kNm)
400 x 800	0	0.02	315.72	1263.16	1344.6	353.25	41.25	861.69	1005.3	271.67	353.25	0	271.67	0
400 x 800	180	0.56	320.63	1286.8	1344.6	353.25	23.68	861.69	1005.3	271.67	353.25	0	271.67	0
450 x 800	270	2.96	237.24	969.4	1005.3	268.92	166.21	969.4	1005.3	268.92	0	268.92	0	268.92

ACI Code

Check At Beam-Column Joints:

1. Flexure Strength Of Joint:

Moment Capacity Calculations for Beam

Concrete Gra = C25 N/sqmm

Steel Grade,f = Fy420 N/sqmm

Beam Size	angle w.r.t. colu	orsion mome	Moment Capacity for Top Reinforcement				Moment Capacity for Bottom Reinforcement				Resultant Moment			
(mm)	(deg)	(kNm)	Mu (kNm)	Ast Req (sqmm)	Ast Pro (sqmm)	Mu Cap (kNm)	Mu (kNm)	Ast Req (sqmm)	Ast Pro (sqmm)	Mu Cap (kNm)	Top @ D (kNm)	Top @ B (kNm)	Bot @ D (kNm)	Bot @ B (kNm)
400 x 800	0	0.01	363.77	1352.42	1372.84	369	89.31	851.43	886.76	242.53	369	0	242.53	0
400 x 800	180	0.37	365.64	1359.71	1372.84	369	68.69	851.43	886.76	242.53	369	0	242.53	0
450 x 800	270	2.1	303.91	1117.5	1140.12	310.28	230.49	1116.2	1140.12	310.51	0	310.28	0	310.51

- **TFS ID – 1094762**

  ACI, Boundary wall confining link calculation has been updated as per the actual rebars available in Boundary zones. Confining link calculation for Wall design with Equal rebar spacing arrangement with and without Boundary element consideration has been enhanced as per actual rebar arrangement.

- **TFS ID – 1096415**

  While installation of software, option is available now to select/un-select installation of Microsoft access database Engine and PostgreSQL database as per requirements. For STAAD users it is not mandatory thus it is kept as unselected.

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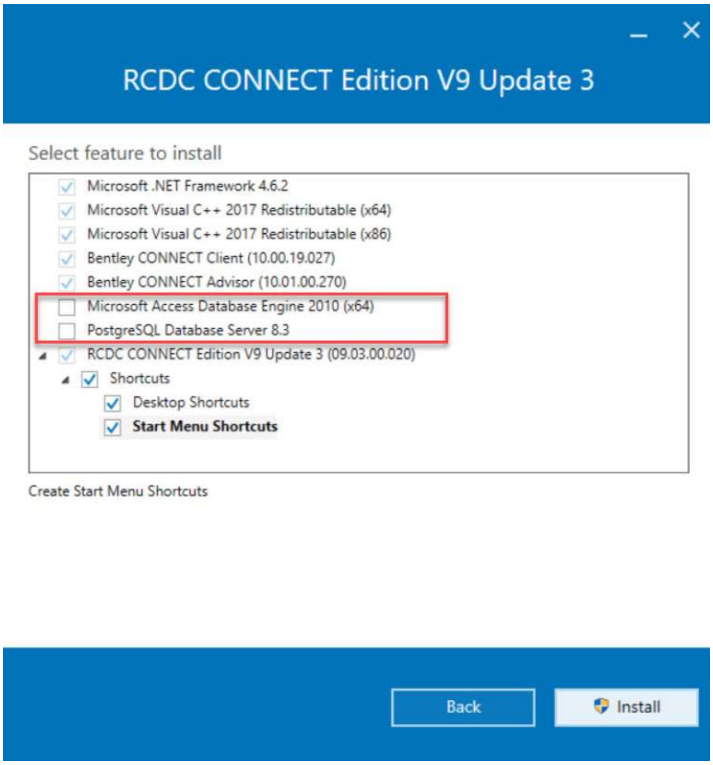

User can select installation of PostgreSQL in case of opening RCDC files earlier than 09.02.00.32 version.

For E-tabs user, installation of Microsoft access database Engine can be selected.

General Defects

- **TFS ID – 1069546**

  Issue related to updating the analysis file with properties and orientation of irregular shaped columns have been resolved. Updating STAAD analysis file for irregular shaped columns created in RCDC file have been correctly exported.

- **TFS ID – 1072130**

  General setting and reinforcement setting form related issue of particular Operating system and screen configuration has been resolved.

- **TFS ID – 1085930 & 1085465**

  Column BBS for IS code, incorrect bending correction was considered for rebars starting from footing level with specified shape. Now, the rebar cutting length has been calculated with correct bend correction.

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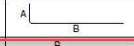
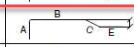
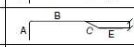
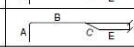
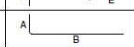
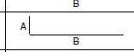
ELEMENT	BAR MARK	LEVEL	BAR NOS.	REBAR	BAR SHAPE	CUTTING LENGTH (MM)	DIMENSIONS					
							A	B	C	D	E	R
C2	B1	1	2	16		6490	300	6237				64
	B2	1	2	12		5915	300	4145	73	12	1429	48
	B3	1	2	12		6410	300	4150	73	12	1921	48
	B4	1	2	12		5920	300	4150	73	12	1429	48
	B5	1	2	12		6405	300	4145	73	12	1921	48
	B6	1	2	16		5835	300	5581				64
	B7	1	4	12		6340	300	6073				48

- **TFS ID – 1087936**

  Column design, sway calculation table has been updated with the correct units. The earlier values calculated and presented were correct, Now the report has been enhanced for more clarity. This is applicable to IS codes and ACI codes.

  IS code:

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	476.389	No Beam	No Beam	-	-	1
Top	476.389	8000 x 400 x 800	No Beam	213.333	-	0.827

Sway Condition (as per Stability Index) = Non Sway
Effective Length Factor along Major Axis = 0.93

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	476.389	No Beam	No Beam	-	-	1
Top	476.389	5710 x 400 x 800	No Beam	298.891	-	0.774

Sway Condition (as per Stability Index) = Non Sway
Effective Length Factor along Minor axis = 0.92

ACI Code:

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		ψ
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	447.81	No Beam	No Beam	-	-	1
Top	447.81	8000 x 400 x 800	No Beam	213.33	-	4.797

Sway Condition (as per Stability Index) = Non Sway
Effective Length Factor along Major Axis = 0.87

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		ψ
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	447.81	No Beam	No Beam	-	-	1
Top	447.81	5710 x 400 x 800	No Beam	298.89	-	3.424

Sway Condition (as per Stability Index) = Non Sway
Effective Length Factor along Minor axis = 0.87

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- **TFS ID – 1089407**

  Euro code, calculation of concrete capacity (V_{RDC}) for circular column has been updated.

Design Of Shear		
Critical Analysis Load Combination	:	13
Critical Load Combination	=	[5] : (LOAD 1: SELF-WEIGHT) +(LOAD 2: VERTICAL-PERMANENT)
Design shear force, Vuy	=	79.8887 kN
NEd	=	172.56 kN
Design shear stress ,vEd	=	1.2699 N/mm²
VRD,c	=	92.5812 kN
As tension	=	1206.36 sqmm
CRdc	=	0.18/γc
	=	0.15
Effective Area	=	62910
k	=	MIN(1 + SQRT(200 / deff),2)
	=	1.9091
ρ1	=	Asmain / Effective Area
	=	0.0192 %
k1		0.15
σcp	=	NEd / (B x D)
	=	2.4412 N/mm²
Shear check		No Shear Reinforcement Required Since VRD,C > Vuy

- **TFS ID – 1092682**

  If the Beams are present at support level in analysis file, reading issue is resolved in the latest release.

- **TFS ID – 1095373 & 1096752**

  Issue related to Boundary wall design in Euro code as per BS EN 1998 has been resolved. The Maximum length of the Boundary element is now restricted to 0.25 x Length of wall. Other issues related to detailing and shear calculations has been resolved.

- **TFS ID – 1097200**

  Issue related to Sway shear calculation for IS 13920-2016 if RAM SS file is selected is resolved.

- **TFS ID – 1098253**

  Euro code, Pile cap capacity form, Validations have been updated for the capacities of the piles for Compression, tension capacities.